

MYSORE
Coffee Experiment Station

Report

1925-30 to 1931-32

I.C.A.R.

The Mysore Coffee Experiment Station—Bulletin No. 3

DEPARTMENT OF AGRICULTURE

MYSORE STATE



REPORT OF WORK ON THE COFFEE
EXPERIMENT STATION, BALEHONNUR

FOR THE YEARS

1925-30

BY

DR. LESLIE C. COLEMAN, M.A., PH.D.

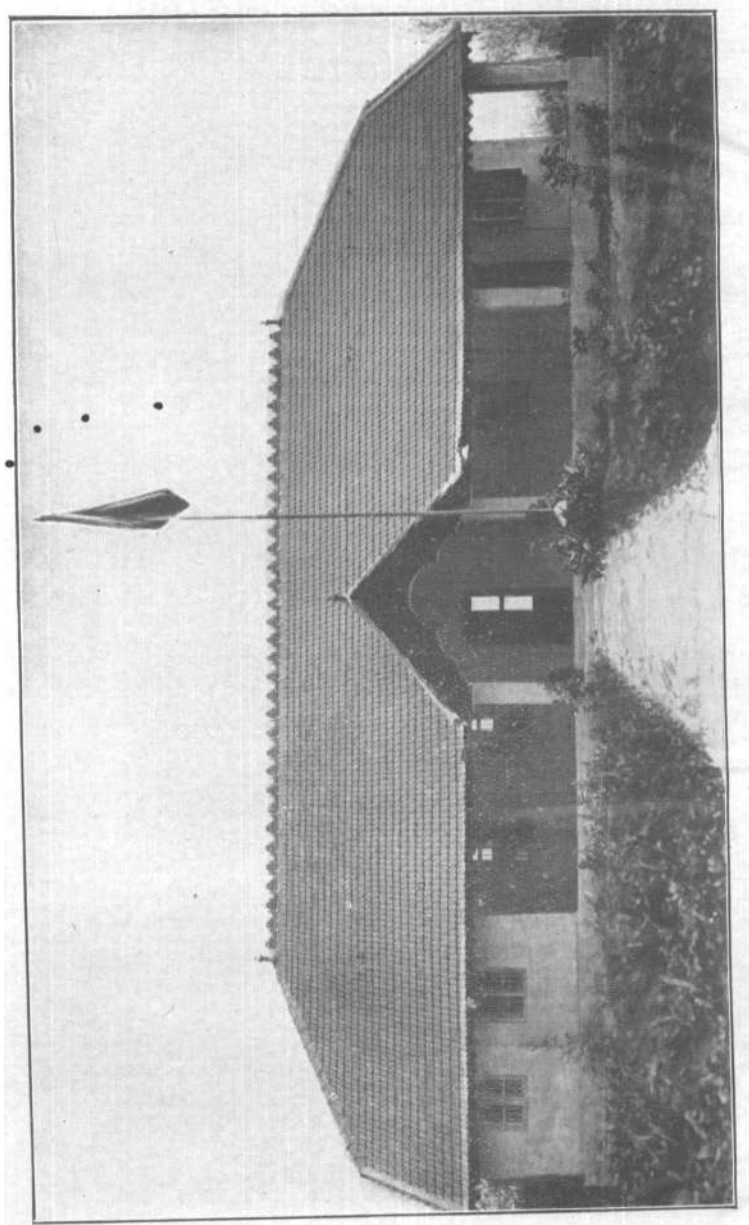
Director of Agriculture in Mysore.



BANGALORE:

PRINTED AT THE GOVERNMENT PRESS

1930



Cere Experiment Station - Research Laboratory.

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MYSORE COFFEE EXPERIMENT STATION, BALEHONNUR.

SUPERVISION.

Dr. Leslie C. Coleman	...	Director.
Mr. E. H. Young	...	} Advisory Board Members.
„ G. V. R. Frend	...	
„ T. B. Malle Gowda, M.L.C.	...	
„ A. Mahomed Hussain	...	
„ S. Pais, B.A., M.L.C.	...	

ADMINISTRATION.

Dr. M. K. Venkata Rao	...	Deputy Director.
Mr. K. H. Sreenivasan	...	Manager.
„ G. N. Kalle Gowda	...	Assistant Manager.
„ Y. R. Narayana Rao	...	Plant Breeder.
„ S. V. Narasimhachar	...	Clerk.
R. Vaideswaran	...	Mechanic.

CO-OPERATOR.

Mr. W. W. Mayo	...	Scientific Officer, United Planters' Association, South India.
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REPORT OF WORK ON THE COFFEE EXPERIMENT STATION, BALEHONNUR, FOR THE YEARS 1925-30.

Introduction.

Work in connection with the investigation of the diseases of coffee was taken up as early as 1915 and a temporary laboratory was set up in Koppa, while field work was also carried on in the Koppa estate on a plot of land kindly placed at the disposal of the Department by Mr. H. Pilkington. The Entomological side of the investigations was carried on in the Hassan District, but there was no chance of investigating the manuring and cultivation of coffee and still less the selection of plants on scientific lines. It was deemed necessary to have an experiment station for investigating the problems of coffee on a systematic scale, an arrangement which would also give an opportunity for systematic and concentrated work in one area as opposed to the sporadic and scattered work that had been possible till then. The planters who were approached in this connection agreed to the proposal and legislative permission was sought to impose a cess of two annas per acre on every block of land classed as coffee land except where the area was fifteen acres and under. The Government agreed to contribute an amount equal to the cess revenue and the amount was to be earmarked as a separate fund for the purpose of investigating the coffee problems. The legislature finally approved of the scheme and the station was started in December 1925. For the preliminary work a sum of Rs. two thousand was given by the United Planters' Association of Southern India who also gave an additional sum of five thousand rupees the next year.

Location.

The farm is situated in the Adigebail village of the Koppa Taluk in the Kader District and is about five miles from Balehonnur on the Koppa road. Two miles of road has been laid from the farm and the farm road joins the

main road at about 400 yards after passing the 29th mile towards Koppa. The road is accessible at all seasons of the year.

Area and Description.

The first work on the farm was taken up on established coffee and this was rendered possible as Mr. C. S. Crawford, owner of Guntenaik and several other estates, generously offered 18 acres of growing coffee land and 18 acres of virgin jungle for a nominal lease, the farm agreeing to pay the land tax amounting to 66 rupees per year. In addition, fourteen acres of *gomal* which were under the control of Government and 165 acres of virgin forest land were included in the area of the farm. Recently the Government have sanctioned the purchase of the area already leased from Mr. Crawford, and a further 65 acres of coffee at a total cost of Rs. 20,000. The total area of the farm is therefore 280 acres (Map I.) of which 82 acres represent growing coffee 15-20 years old, 185 acres of jungle fit for growing coffee and 15 acres of land useful for grazing of cattle and buildings. The soil is of varying character and represents, about as fully as it is possible in any one locality, the different kinds of soil upon which coffee is now grown. The rainfall of the station is normally about 100 inches although within the last three years the fluctuations have been high. The following table furnishes the rainfall of the station from 1926 to date month by month:—

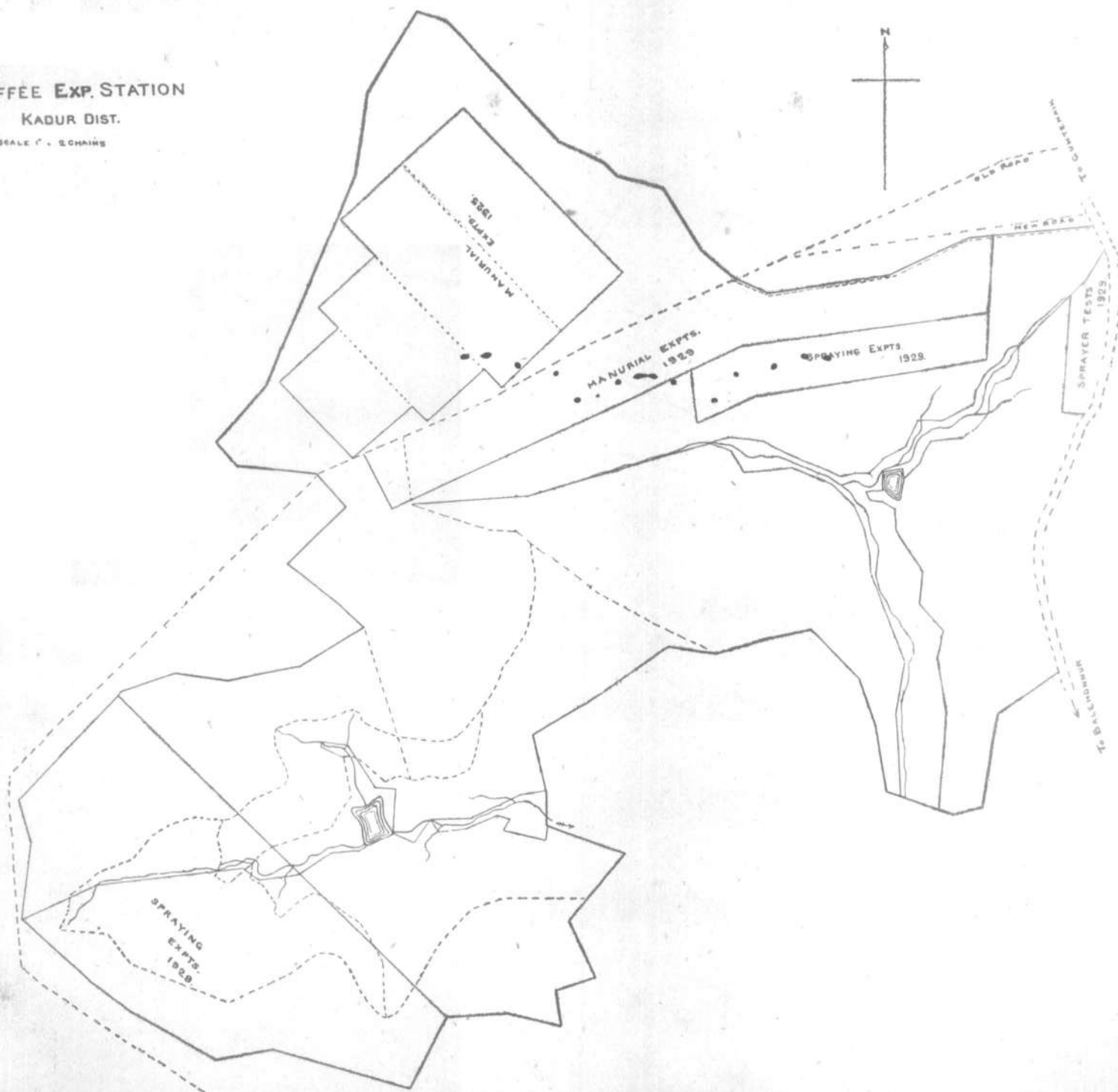
		1926	1927	1928	1929
January	...	...	...	0'10	0'27
February	...	0'27	...	2'46	...
March	...	0'19	1'55	3'12	...
April	...	0'47	2'99	2'36	10'75
May	...	2'68	7'60	1'67	5'22
June	...	6'95	13'39	16'30	20'19
July	...	33'86	52'34	22'25	34'30
August	...	34'07	17'81	25'07	17'35
September	...	6'15	8'06	1'80	9'04
October	...	3'45	0'66	12'98	4'79
November	...	...	3'11	0'59	2'14
December	...	0'03	...	1'11	...
Total	...	88'12	107'51	89'81	104'05

MAP I.

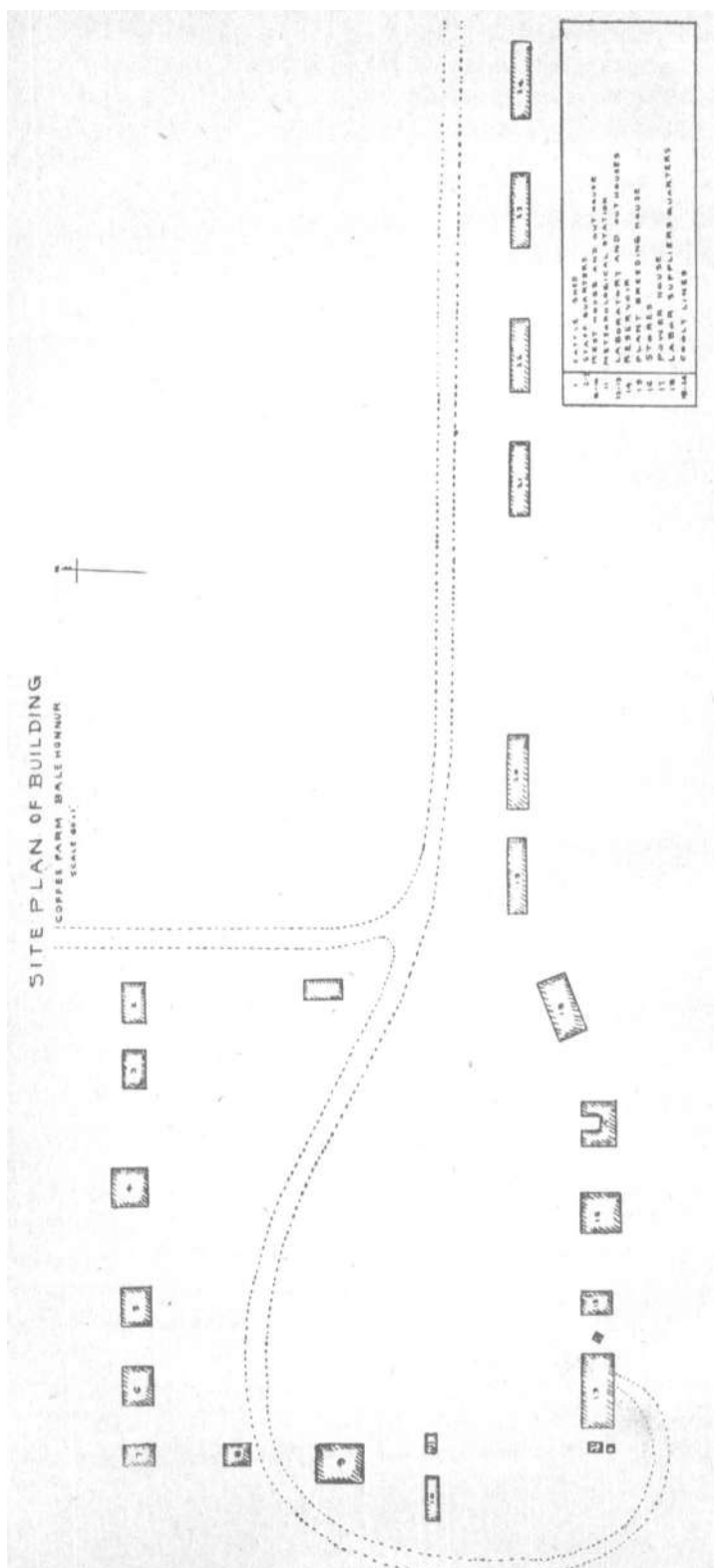
COFFEE EXP. STATION
KADUR DIST.
SCALE 1" = 2 CHAINS

KADUR DIST.

SCALE 1" = 2 CHAINS



PLAN I.



The elevation is about 2,700 feet above sea level and it is therefore slightly below the level that is usually considered most suitable for the growing of Arabica coffee. In spite of these drawbacks, the farm satisfies certain other conditions for laying out scientific experiments properly. It is obviously impossible to supply in one place all the conditions prevalent in the coffee area of Mysore where the elevations range from 2,500 to 4,500 feet above sea level and rainfall from 50 to 300 inches with soil ranging from almost grass land of the savannah type to fertile ever-green forests. The environment in which the farm is situated falls within the limits specified above.

Buildings and Accommodation. (See Plan I.).

At present there are 22 buildings as shown below :—

1. Laboratory with Gas House, (See Figure 1).
Frontispiece.
2. Guest House with Indian and European Kitchen and Garage.
3. Seven Staff Quarters, (See Figure 2).
4. Four Cooly Lines, (See Figure 3).
5. Power House and Workshop.
6. Stores.
7. Propagating House.
8. Pump House.

Electric lights, gas and water are available on the farm and it is proposed to supply filtered water for the quarters and the laboratory in the near future.

Administration.

The staff consists of a Manager, Assistant Manager, a Plant Breeding Assistant, a Clerk, two Mechanics and a peon. The routine work of the farm is controlled by the Deputy Director under instructions from the Director of Agriculture. The more important phases of work are discussed and decided upon by the Director of Agriculture and the Advisory Board consisting of five gentlemen representing the planting interests in Mysore and South

India. The Board usually meets about four times a year, reviews the work done and offers fresh suggestions for work. The following list gives the names and addresses of the members constituting the advisory committee at present:—

E. H. Young, Esq., Oosoor Estate, Saklespur P. O., Representative of the United Planters' Association of Southern India.

Hajee A. Mohamed Hussain, Esq., Kardibetta Estate, Kenchamma Hoskote P. O., Representative of the Indian Planters of Hassan District.

T. B. Malle Gowda, Esq., Togaribankal Estate, Chickmagalur, Representative of the Indian Planters of Kadur District.

S. Pais, Esq., Kudaregundi Estate, Mudigere P. O., appointed by the Mysore Government.

G. V. R. Frend, Esq., Guntenaik Estate, Balehon-nur P. O., Representative of the Mysore Planters' Association.

Following an arrangement come to between the Mysore Government and the United Planters' Association of Southern India, Mr. W. W. Mayne, Scientific Officer of the Association works on the Station under the direction of the Director of Agriculture, Mr. Mayne, joined duty in October 1928.

The programme of work laid out by the Director of Agriculture has been approved by the Government in their letter No. D. 9995-6—A & E. 252 27-4, dated Bangalore, 20th March 1928. It is given as an appendix (Appendix A.).

Laboratory and Library Equipment.

The laboratory is equipped with all the apparatus necessary for a study of the diseases of coffee and for work on coffee breeding, this being work that must be carried out on the spot. As the Agricultural Department has a fully equipped chemical laboratory with a fairly large staff in Bangalore, it is unnecessary at present to provide laboratory facilities for chemical work on the station. The necessary work connected with the preparation of samples will be carried out on the station and the samples

despatched to Bangalore for analysis. The laboratory is also provided with gas, water and electricity. It is proposed later on to make special provision for Entomological work in the shape of an insectary.

The library is provided with standard reference books on plant diseases and plant breeding, and an attempt is being made to gather from all parts of the world every publication on coffee which is of any value. A special room in the laboratory building has been set apart for library and herbarium purposes.

Government have sanctioned the establishment of a Meteorological Station on the farm and the necessary equipment including wet and dry bulbs, maximum and minimum thermometers, standard barometer, anemometer, and windvane have been obtained and have been installed. In addition it is proposed to equip the station with an automatic sunshine recorder to give information on a subject which has received scanty attention in the *ghats* where the influence of the monsoon is greatest.

Experiments in Progress.

Chemical work.--The work has been continued practically on the same lines as hitherto. A brief resume is given below and the data obtained till now are given in Appendix B.

General manuring.--Testing of the effects of Nitrogen (N), Phosphoric acid (P) and Potash (K). N plus P, P plus K, N plus K, and N plus P plus K both in presence and absence of lime. The dosage is 25 lbs. N, 37.5 lbs. P_2O_5 and 50 lbs. K_2O .

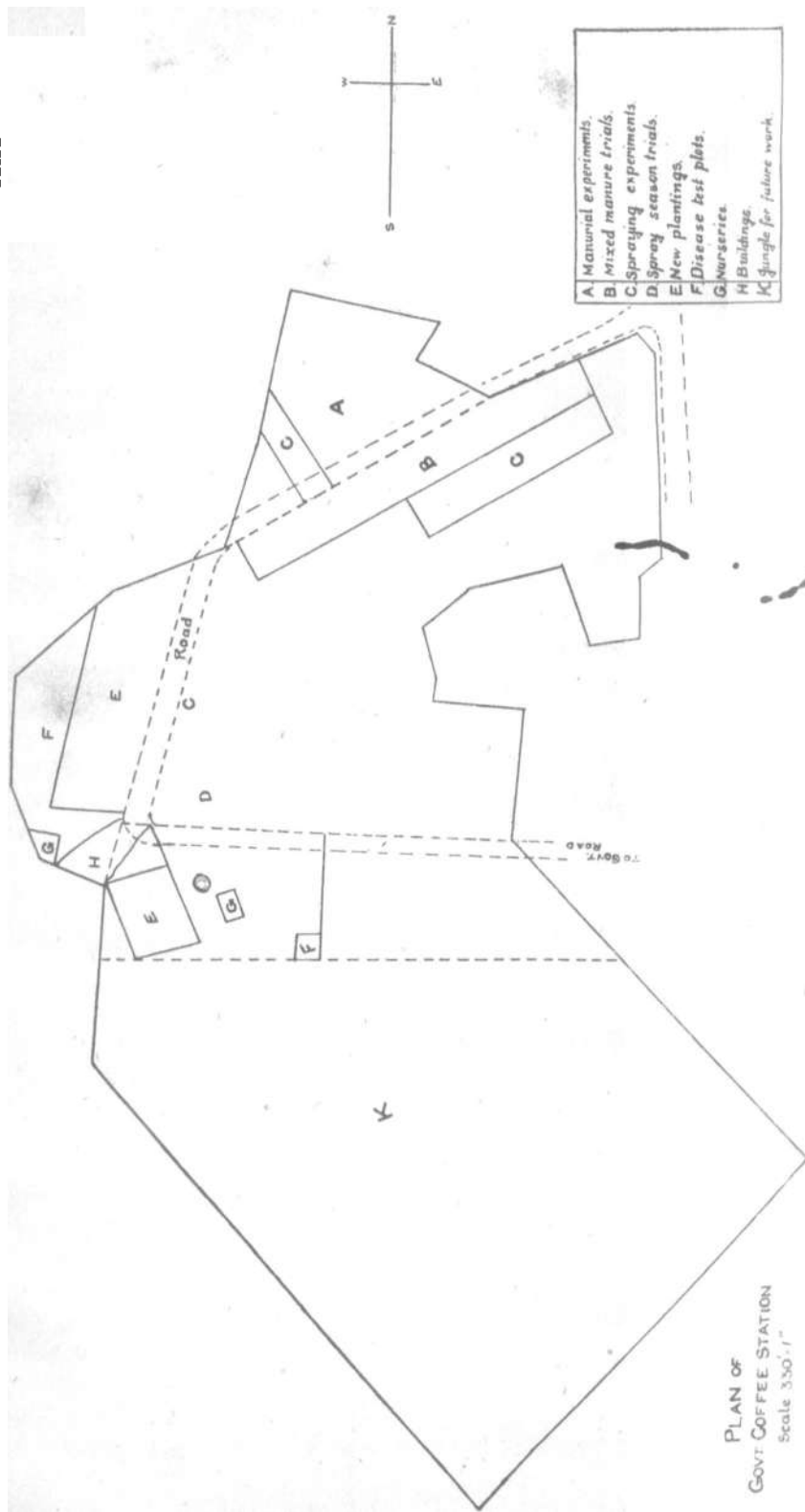
Nitrogenous manuring.--Originally this experiment consisted of testing ammonium sulphate, oil cake, floranid and green manure as sources of nitrogen for the plant, the other two plant foods being supplied uniformly for all plots. Their effect was studied both in the presence of lime and its absence. The green manure experiment has been replaced by sodium nitrate and the test is being carried on with nitrate of soda kindly supplied for experimental work through the Chilean Nitrate Committee.

Dosage experiments.--The best dose of mixture to be given for coffee is being determined by giving 25 lbs. N per acre, 37.5 N per acre and 50 lbs. N per acre, the other two ingredients being proportionately increased to maintain the ratio of 2:3:4 of N, P, K.

Phosphate Experiments.--Similar to the nitrogen series, superphosphate, basic slag, steamed bone and raw bone are being tested as sources of phosphoric acid supply for the plants, the remaining two plant foods being the same. Its effect in the presence and absence of lime is also being investigated.

Potash series.--The same type of experiment has been carried on to decide the relative merits of potassium sulphate and potassium chloride as sources of potash both in the presence and absence of lime. Map II shows the location of the manurial and other experiments. With the acquisition of the extra area of coffee, manurial experiments are being greatly expanded with the object of obtaining the most accurate information possible on the manuring of coffee.

MAP II.



MYCOLOGICAL.

Importation and testing of new types of sprayers.—During the year, in addition to the one gallon pressure sprayers which were hitherto used for work, three different types of sprayers were imported and are being tested for comparative efficacy and cost.

The Drake and Fletcher Headland Sprayer worked by three men at the pump, four for the hose and one for agitating and supply of the mixture, at a nominal pressure of 200 lbs. per square inch and an effective pressure ranging from 150—200 lbs. can spray one to one and a half acres per day. This sprayer is shown in Figure 4.

The Holder Battery Sprayers six, each of 22 litre capacity, worked by a gang of eight men, six to carry sprayers, one to pump and one to supply the mixture can cope with spraying approximately the same area. The spray is finer but the weight of the sprayer with the liquid is about 30 lbs. and very few people among the coffee estate labourers can carry this weight on their back and carry on spraying for any length of time. A smaller container will be most likely an efficient substitute. These sprayers are shown in Figures 5 and 6. One of them is being charged.

Motor Sprayer.—This is a power sprayer manufactured by Holder with four lines of hose (the original machine carried only two and the four hose arrangement has been specially designed for the Department) and can handle about three acres per day with a gang of six men four for the hoses, one for supplying spray mixture and one for attending to the engine. The petrol consumption is about two gallons per day to which has to be added one bottle of mobil oil. The cost is likely to work out slightly higher than in the case of the Headland Sprayer but the spraying is very even. For large estates machines of this type seem to hold out considerable promise. This sprayer is shown in Figure 7.

2. *Testing of Alum Bordeaux with ordinary Bordeaux mixture and fungicidal dust* has been undertaken on the farm and the effects are being watched. Although no quantitative data are yet available, the indications are that the alum Bordeaux is just as effective as ordinary Bordeaux in the control of Black Rot and Leaf Disease of Coffee. The powder dust is distinctly inferior as a means of control.

3. *Dusts imported from America*, Kolo dust, Bordeaux dust and Oxidised sulphur and one dust, Verminite from England, have been tried as a means of controlling

fungus diseases. Even with the very best efforts, it has been found that none of them has been effective mainly because it will not stick to the under surface of the leaf. A new dust put up by a Bombay firm which had copper sulphate, lime with large percentage of magnesia and casein ground into a fine powder was apparently enquired after by a few planters and as the laboratory tests of this dust are unsatisfactory, a note was published in the *Planters' Chronicle* by the Director warning the planters against the purchase of this material. Another firm in Bombay has attempted to put on the market a patent preparation apparently containing raw sulphur ground into a fairly fine powder and screened through a mesh, as a fungicide. It has not the same fineness as the Kolo dust and stands still less chance of adhering to the leaves.

4. *Testing of ordinary and half strength Bordeaux.*—To test the relative efficiency of a weaker strength of solution, an area was marked and sprayed with a 5-5-100 (weak) solution as opposed to a 5-5-50 solution in November last. Half of it has been resprayed with similar strength of solution to watch the effects of one spraying as compared with two sprayings of ordinary weak solutions.

5. *Testing of the effect of various adhesives with Bordeaux.*—This work is being carried out with a number of adhesives to ascertain which is the most efficient in holding the spray on the leaves. While the results of experiments with different sprayers and sprays are not yet complete, information of great practical importance has already been obtained. As the area of coffee sprayed is increasing rapidly and as the interest in the subject has spread to all classes of planters, it has become necessary to publish at once the results of our investigations so far. This is being done.

6. *Moss control work.*—Repeated enquiries have been received in regard to a method for controlling moss on coffee stems as it is believed by some planters that moss growth is deleterious to the growth of coffee plants. Trials have been made with sulphuric acid, copper sulphate, iron sulphate and lime either singly or in combination and the results till now indicate the possibility of controlling this epiphyte by the use of iron sulphate either singly or in combination with copper sulphate. The progress of the development of moss on these stems will be watched during the present monsoon.

7. *Blackrot Investigation.*—For taking up a study of the causes which are responsible for the outbreak of

the black rot, plants which had a very heavy disease have been marked and are being watched to find out if these will serve as centres of infection during the coming season. Infected leaves collected two years ago were placed in boxes protected with rabbit netting and allowed to remain in the estate under as natural conditions as possible. Some of these old infected leaves were then attached to healthy leaves on coffee plants during the last monsoon. The disease spread on to the healthy leaves from the old diseased ones. This definitely establishes the fact that the disease is carried over through the dry season on the old diseased leaves.

8. *Work of the Scientific Officer, United Planters' Association of South India.*—As stated above, Mr. Mayne joined duty in October 1928. After a preliminary tour in the main coffee areas of Mysore and Coorg to enable him to become familiar with the problems awaiting investigation, Mr. Mayne took up the study of certain important diseases of coffee. His attention has, up to the present, been devoted mainly to leaf disease, 'die back' and the various root diseases of coffee. Two isolated blocks of five acres each, in two different soil areas, have been set apart for Mr. Mayne's use. On these he will be able to study the progress of the various diseases in the field and will at the same time be able to carry out infection experiments under field conditions. He will further be able to co-operate with the plant breeding section of the station in studying the resistance of the various selections of coffee developed or tested on the station to the important diseases which attack coffee in South India. This co-operative study is certain to lead to valuable results.

Entomological work.—The attention of the Entomological Section is being devoted, at present, mainly to the study of coffee borer. This work has to be carried out in areas and on estates where borer is particularly prevalent. As field investigations have been in progress in a number of these estates for several years it would be inadvisable to discontinue this work now even were conditions as regards borer infestation favourable for study at the station. As a matter of fact, there is very little borer attack on the station and it would seem to be unwise to change conditions by the cutting out of shade so as to favour an increase of borer, more especially as that would undoubtedly interfere with the other experimental work being carried on.

One problem that is being taken up at the station is the possibility of preparing a combined spray to control at the same time leaf disease and green bug. There is some evidence that where spraying with Bordeaux for the control of leaf disease is practised green bug increases. It is too early to say whether this will prove a serious obstacle to the introduction of spraying with Bordeaux, but it is certainly necessary to be prepared for such a contingency. Work has been taken up on the station in this connection in collaboration with the Entomological Section of the Department but no definite results have as yet been obtained.

Plant Breeding work.—The work has consisted of experiments given below and no results can be reported for a considerable time to come as coffee does not come to full bearing until about five years old and then the accumulation of data will take some more time after that.

(a) Improvement by selection in Arabica coffee for high yield.

Improvement by selection in Robusta coffee for high yield.

Improvement by selection in Hybrid coffee for high yield.

(b) Grafting of Arabica suckers on Robusta and Liberian coffee by cleft and double cleft methods and approach grafting on Robusta and Arabica seedlings. The grafts have been successful and a number of them have been planted out in the field to test their performance. There are about 300 grafts in the nursery and they will be planted out in the field this season. Investigations as to the best method and most satisfactory time for grafting have been carried out and are being continued. Figures 8 and 9.

(c) Growing of hybrids of Liberica-Arabica and Robusta-Arabica and studying their progeny. Work has also been done with regard to selfing selected coffee plants and artificially pollinating Robusta, Arabica, Kent and Netrakonda. The seed will be used for further breeding work.

(d) Testing of varieties of coffee for yield and disease resistance notably such varieties as Maragogype, Canephora, Golden drop, Uganda, Quillou and Excelsa.

(e) Selecting for resistance to root rot by collecting seed from plants surviving in heavily infected areas.

Other crops.—A plot has been laid out for testing the suitability of different green manure crops, notably Boga-

medaloea, *Leucaena glauca*, *Crotolaria striata*, *Cassia hirsuta* and *Cassia tora*. Seeds of other green manure plants have been imported from Ceylon to extend this work in the coming season.

Results of work on the Chemical side up-to-date are tabulated in Appendix B. Further work will be necessary before any conclusion can be drawn. The nature of the Mycological and Entomological problems is such that some time must elapse before definite results can be obtained. On the plant breeding side extensive selections have been made and this work will be continued vigorously in the next few years. A list of plants now growing is furnished in Appendix C.

Programme of work for the next year:—

(1) Continuing the work on the lines already laid down by the Director and approved by the Government.

(2) Extending experiments on the control of moss from the point of view of farm economics.

(3) Developing the 65 acres of coffee land newly bought by means of spraying and cultivation.

(4) Laying out new experiments on testing of additional manures such as Ammophos, Monammonphos, Parry's mixture, etc., in consultation with the Chemical Section.

(5) Taking up plant breeding work on cardamoms by importation of seedlings from the cardamom estates in South India and the Bombay Presidency and by selection in the areas in the State.

(6) Laying out plots for testing disease resistance by infecting the soil and planting the seedlings from the plant breeding section in this area to test their relative resistance.

(7) Artificial hybridisation of Kent, Arabica and Robusta varieties and studying their progeny.

(8) Laying out manurial experiments for studying the effect of manures on young coffee plants (from one year old up to the time of coming to bearing).

(9) Laying out cement cisterns for studying the effect of lime on coffee and taking up work on Hydro-ion concentration.

(10) Continuing to give advice for control of diseases of coffee and visiting estates as far as possible for selection work.

While the programme laid above is only for the next year and tentative, additional work is being done both by

the Entomologist and the Chemist in other coffee growing areas of Mysore. Mr. Mayne, the Scientific Officer of the United Planters' Association of South India, who has excellent opportunities for visiting other coffee areas outside Mysore will, in the course of his work, tackle problems which are not mentioned above. In addition the staff of the station is always willing to take up any other problems that may be brought to its attention by the planters and investigate them as far as time and facilities permit. The study of the weed flora of the estates will be taken up as far as possible to correlate characteristic vegetation with the soil types in coffee areas.

[illegible]

C	Check
N	Nitrogen
P	Phosphate
K	Potash
OC	Oil cake
A	Ammonium sulphate
F	Flouranid
SN	Sodium nitrate
S	Superphosphate
BS	Basic slag
SB	steamed bone
RB	Raw bone
K ₂ SO ₄	Sulphate of potash
KCl	Chloride of potash

C	Check
N	Nitrogen
P	Phosphate
K	Potash
OC	Oil cake
A	Ammonium sulphate
F	Florinid
SN	Sodium nitrate
S	Superphosphate
BS	Basic slag
SB	steamed bone
RB	Raw bone
K ₂ SO ₄	Sulphate of potash
KCl	Chloride of potash

APPENDIX A.

Programme of work for the Coffee Experiment Station,
Balehonnur.*

MAIN PROJECTS.

The main projects on the farm may be outlined under the following heads:—

(a) *Chemical*.—A study of the manurial requirements of coffee.

(b) *Botanical*.—An attempt to improve ~~coffee~~ in vigour, quality and disease resistance through selection and hybridization.

(c) *Mycological*.—A study of the diseases of coffee the chief of which are leaf disease, black rot, die back and root rot with the object of bringing them under control.

(d) *Entomological*.—A study of the insect pests of coffee the chief of which are green bug and coffee borer.

(a) *Chemical*.—For the purpose of carrying on manurial experiments it is necessary to use coffee of as uniform a character as possible. The growing area handed over by Mr. Crawford fulfills this requirement to as great a degree as almost any area I have seen. Of this area, only the most uniform inner portion has been laid out in plots for the testing of different manurial treatments as illustrated in the enclosed plan (Plan II). The balance of the area not being very suitable for manurial experiments will be used for experiments on leaf disease and die back, the two diseases which are to a certain extent prevalent on this particular piece.

This manurial area should be reserved for the purpose for at least ten years by which time we may have another area planted up and brought to maturity which can be used for the purpose.

* This programme was prepared and approved by Government in 1928 at which time we had only 17 acres of mature coffee. The recent addition of 65 acres has enabled us to embark on a much more extensive scheme of experiments and spraying than was then possible.

(b) *Botanical*.—The work on breeding for vigour, quality and disease resistance should form the main work of the farm and should on no account be jeopardised by or sacrificed to anything else. Breeding of a perennial crop such as coffee will require time. I estimate at least ten years will be required to give the first practical results and it will probably require twice that period to give results of the greatest value. This necessitates that the plan of operations must be most carefully considered beforehand and once fixed must be adhered to rigidly and carried out with the greatest perseverance. A changing policy would jeopardise the work and lead to deplorable waste of time and money.

Breeding work will involve the growth of many thousands of individual plants under as nearly uniform conditions as possible. This work will necessitate close and continuous observation on the part of the staff. The breeding plots should, therefore, be large and as near to the buildings as the requirements of soil will permit. I propose to reserve ten acres of the best part of Mr. Crawford's jungle and 15 acres of the Government jungle for this purpose. These areas are about a hundred yards from the laboratory site.

In addition to the 25 acres reserved for breeding work, an area of about 100 acres should be reserved for the multiplication of our improved varieties and the production of seed for distribution. To prevent cross fertilization of these varieties it will be necessary to have the multiplication plots surrounded by belts of jungle. These multiplication plots will not come into use probably for ten years as it will take that long to develop our first selections to the point where we are able to multiply them.

In addition to this definite breeding work, investigation of the possibility of growing high quality Arabica coffee on vigorous root stocks such as Robusta by grafting should be taken up immediately. This will demand the remainder of the area in Mr. Crawford's jungle, roughly 7 acres.

(c) *Mycological Investigations*.—As already noted, the main diseases at present to be found on coffee in South India are leaf disease, black rot, die back and root or stump rot. The investigation of these diseases can be undertaken partly on the area of growing coffee handed over by Mr. Crawford. However, black rot and stump rot are not serious on the plot nor are they likely to be in the near future. Arrangements will be made immediately with

planters in the neighbourhood and farther afield for the provision of facilities for field study. Mr. Crawford's large holdings in the neighbourhood should furnish us with all the materials we require for the purpose within a radius of a few miles. The chief additional requirements in this connection are laboratory facilities for investigation on the spot and these will be provided as fully as possible.

In addition to the above we have the investigation of the value of various fungicides and of the efficiency of the various types of spray machinery. I have already had assurances from Mr. Friend, Mr. Crawford's manager, that he will provide us with facilities in this regard.

I may note that practical results are likely to accrue from this type of work much sooner than from our breeding work but the final results from it are not likely to be so important.

(d) *Entomological*.—As in the case of Mycological work, facilities for field work on the insect pests of coffee will have to be sought largely on private estates in the coffee area. The station will furnish us with the essential laboratory and insectary facilities and will serve as a centre for the work.

Other Coffee Problems.—There are of course a large number of problems connected with coffee cultivation which are not covered by the above programme. Among these may be mentioned problems of cultivation and shade. These problems are, I consider, not of such pressing importance as to warrant our locking up comparatively large blocks of land for the purpose and so interfering with the more important breeding work which should remain the main object of the station's activities. There is always danger of taking up more problems than the staff of the station can handle and our facilities will warrant. We must guard most carefully against this danger.

Subsidiary Lines of Work.—While the station should remain primarily one for the investigation of coffee problems, I believe it should be utilized for the study of other planters' crops as well. Among these may be mentioned cardamoms, pepper, and tea, all crops either of present or potential importance to the State. The natural facilities for the study of cardamom cultivation and varieties are, I consider, particularly good and, as this important crop has heretofore received practically no scientific attention, we have a large and useful field before us. I propose starting on a study of cardamom varieties with the object of

obtaining materials for breeding work. A study of cardamom pests and diseases as also cardamom manuring will be taken up as occasion permits. Somewhat similar work will be undertaken on pepper, while in connection with tea, the only problem I should propose taking up in the near future is a study of root rot, a disease either closely related to or identical with the root rots of coffee. I may point out that starting work on these will not involve the utilization of any land at all suitable for coffee experiments.

An examination of this memorandum will show that it will be necessary to reserve about 150 acres for experimental work which will be brought into cultivation in from 15 to 20 years. In the next few years an annual planting of from 5 to 10 acres is all we should undertake as we must reserve our jungle for the planting of our selected varieties. This indicates clearly that we must not look to direct revenue from the station as a very important factor in financing the station's activities. It would, I consider, be a most serious breach of trust if we were to attempt to make the station even to a moderate degree self-supporting by sacrificing the real functions of the station to the clamour for revenue. The planting up of large areas of jungle now would simply make it impossible to carry on the real programme of the farm, for when we came to the stage when we wanted to multiply our selections we should either have no land on which to grow them or would have to uproot coffee of say 10 or 15 years standing. Even then the land would probably be very seriously reduced in value from a coffee growing standpoint.

The following is the summary of the important points in this memorandum :—

1. This station must be used as an experiment station and not for the purpose of attempting to grow a large acreage of coffee at a profit.

2. Coffee breeding should be the chief item of the work on the station and about 125 acres should be set apart for the actual breeding work and the multiplication of seed from selected varieties once they are secured. It is unlikely the whole of this land will be brought under cultivation within a period of less than 20 years.

3. Work on the manurial requirements of coffee has already commenced and should form the main item of work on the area of coffee handed over by Mr. Crawford probably for the next ten years. As areas are planted up

to our selections, these will become available for further manurial experiments and for such other experiments as those on cultivation, influence of shade, etc.

4. The work on the diseases of coffee will be centred in the station. Field work in this connection will be carried on as far as possible in the station, but will have to be extended to estates and areas where the particular diseases are most prevalent. This applies especially to the study of control measures.

5. Work on the insect pests of coffee will have to be conducted in much the same manner as that on diseases.

6. In addition to the investigation of coffee problems, those concerning other planters' crops such as cardamom, pepper and tea should be taken up on the station only when the staff and funds permit. They should in no way be allowed to interfere with the real functions of the station as one for the study of coffee problems.

LESLIE C. COLEMAN,
Director of Agriculture.

APPENDIX B.

The following statement gives the yield for various treatments for 5 years since 1925.*

Yield of Berries in lbs. per acre.					
	1925-26	1926-27	1927-28	1928-29	1929-30
Bulk	159	932	396	335	...
II. General manurial requirements.					
Check	435	2,313	584	706	1,718
Groundnut cake (N).	413	2,256	547	809	1,927
Super (P)	536	2,530	610	950	1,818
Potash (K)	436	2,327	850	748	1,740
N. P.	557	2,518	684	814	2,067
N. K.	557	2,336	591	673	2,028
P. K.	416	2,396	499	607	1,683
N. P. K.	509	2,854	607	970	1,691
III. Various Nitrogenous manures.					
Check	398	2,068	601	835	1,155
G. nut cake	418	2,138	476	1,071	1,193
Am ₂ SO ₄	341	2,484	782	914	1,470
Floranid	410	2,250	776	888	1,196
Nitrate of Soda	...	...	...	823	1,200
IIIa. Varying doses of complete manure.					
Check	264	1,449	398	691	1,022
Complete Manure Single dose.	252	2,361	441	833	1,187
Complete manure 1½ doses.	381	2,190	449	920	1,217
Complete manure 2 doses.	336	1,884	380	726	1,180
IV. Various phosphatic manures.					
Check	297	1,484	754	517	1,293
Super	365	1,764	976	618	1,708
Basic slag	288	1,702	720	600	1,587
Steamed bone	277	1,309	620	668	1,283
Raw bone	241	1,350	697	615	1,188
IV. Various Potash manures.					
Check	214	1,174	905	420	1,489
K ₂ SO ₄	186	1,271	881	552	1,639
KCl	221	1,455	943	560	1,750

*The differential treatment was started in September 1925. Its effect on yields seen only partially in 1926-27 and more completely from 1927-28 onwards.

APPENDIX C.

Statement showing the selected strains on the Station
and the year of planting, etc.

Number allotted on the Station	Variety	Name of Estate
10	Coorg 1926 planting	Subbankudige
13	Do do ...	Igoor
14	Talagony selection 1926 planting	Kumergod
15	Coorg do	Baskul
16	Kent do	do
17	Coorg selection do	Chandrapore
18	Chandrapur Hybrid do	do
20	Blue Mountain do	Sanpige
21	Coorg do	do
31	Bunch bearing do	Biccode
54	Hybrid 1927 planting	Subbankudige
55	Old Coorg Coffee 1927 planting	do
56	Nethrakonda do	Nethrakonda
57	Parent of Kent do	Wager
58	Hybrid do	Kumergod
59	Golden Drop do	Merthikan
60	Hybrid do	Arthavalli
64	Yellikodige special 1928 planting	Harley
65	Old Coorg 'prolific bearer' do	Keslurvurthy
66	Robusta Arabica Hybrid do	do
67	Coorg Type do	do
69	Bettadamalale Hybrid do	Thogari Handloo
71	Special Kent do	do
75	Cross work like Arabica liberica, 1928 planting.	Ubban
78	Hybrid 1928 planting	Dubla
85	Coorg Type do	Bykaravalli
SEEDLINGS IN THE NURSERY TO BE PLANTED DURING THIS SEASON.		
86	Hybrid No. I	Attikan
87	do No. II	do
88	do No. III	do
89	do No. IV	do
90	do No. V	do
91	Hybrid No. I	Hegggoodloo
92	do No. II	...
93	do No. III	...

APPENDIX C—*contd.*

Number allotted on the Station	Variety	Name of Estate
94	Selection	... Bangalore
95	Hybrid (29)	... Chandrapore
96	do (38)	... do
97	do (39)	... do
98	do (42)	... do
99	do (49)	... do
100	do (50)	... do
101	No. 5	... Kumergod
102	do	... do
103	Nalakanad "A"	... do
104	do "B"	... do
105	Arbid khol kent type	... do
106	No. 4	... Dubla
107	No. 9	... do
108	No. 11	... do
109	No. 14	... do
110	No. 23	... do
111	No. 27	... do
112	No. 30	... do
113	Golden Drop	... do
114	Robusta	... Guttikan
115	No. 2 Interior Hybrid	... Betkodi
116	No. 1 Road Side Hybrid	... do
117	Robusta Arabica Hybrid	... Bettadamane
118	Cross between Mockett's and Kent	... Warthyally
119	Hybrid No. 2	... Holalu
120	do 4	... do
121	do 8	... do
122	do 10	... do
123	do 11	... do
124	do 13	... do
125	do 17	... do
126	do 20	... do
127	do 22	... do
128	do 25	... do
129	do 26	... do
130	do 28	... do
131	do 31	... do
132	do 33	... do
133	do 41	... do
134	do 42	... do
135	do 44	... do
136	do 49	... do
137	do 68	... do
138	do 70	... do

APPENDIX C—*contd.*

Number allotted on the Station	Variety	Name of Estate
139	Hybrid No. 91	... Holalu
140	do 94	... do
141	do 129	... do
142	do 131	... do
143	do 148	... do
144	do 167	... do
145	do 170	... do
146	do 184	... do
147	do 188	... do
148	do 200	... do
149	do 229	... do
150	do 260	... do
151	do 385	... do
152	do 395	... do
153	do 398	... do
154	Thunde Kan Hybrid 12	... Santaveri
155	do 13	... do
156	do 14	... do
157	do 16	... do
158	Hosakan Hybrid 19	... do
159	do 20	... do
160	do 23	... do
161	do 28	... do
162	do 32	... do
163	do 42	... do
164	do 50	... do
165	Kesinvurthy Hybrid No. 30	... Kesinvurthy
166	Beetay Kan Hybrid No. 1	... Santaveri
167	do do 8	... do
168	do do 4	... do
169	Take Hybrid No. 10	... do
170	Hybrid No. 34	... Mavinkere
171	do 83	... Channahadlu
172	do 88	... do
173	do 101	... do
174	do 106	... do
175	do 149	... do
176	do 157	... do
177	do 159	... do
178	Someswara Kan Hybrid	... do
179	Arabica selection - Mallarasangudda	... do
180	Hybrid No. 2	... Hirehasodi
181	do 4	... do
182	do 6	... do
183	do 7	... do

APPENDIX C—*contd.*

Number allotted on the Station	Variety	Name of Estate
184	Hybrid No. 9	Hirehasodi
185	do 10	do
186	do 15	do
187	do 21	do
188	do 22	Kogode
189	do 29	do
190	do 31	do
191	do 34	do
192	do 35	Kanador
193	do 36	Kogode
194	do 37	do
195	do 38	Kanador
196	do 39	do
197	Kartikere Hybrid No. I	Kartikere
198	do do II	do
199	do do III	do
200	Honnemetti selection	Honnemetti
201	Robusta	Kerehuckloo
202	Hybrid	Sripathi Kan
203	Hybrid, Bettadamane	Bettadamane
204	Arabica I	Mattasagar
205	do II	do
206	do III	do
207	Orange yellow, Hybrid	Kogode
208	Drooping Hybrid	Hirehasodi
209	Jackson Hybrid 4 year old plant	do
210	Marigogypi Type I	Cowcoody
211	do II	do
212	do No. 1 Hybrid. Free bearing.	do
213	do Hybrid II generation Type I.	do
214	do do Type II.	do
215	Dodluckunda II generation II plant Liberia x Coorg.	do
216	Basavanahalli via Igoor	do
217	Golden drop	do
218	Newcome Hybrid	do
219	Bettagere Hybrid	Bettagere
220	M. 7	} Selections by the Scientific Officer, U.P.A.S.I.
221	M. 8	
222	M. 9	
223	M. 10	
224	M. 12	
225	M. 13	

APPENDIX C—*concl'd.*

Number allotted on the Station	Variety	Name of Estate
226	M. 14	Selections by the Scientific Officer, U.P.A.S.I.
227	M. 16	
228	M. 17	
229	M. 18	
230	M. 19	
231	M. 20	
232	M. 21	
233	M. 22	
234	M. 23	
235	M. 5	
236	M. 6	
237	M. 24	
238	Blue mountain Jamaica	Balur
239	Old Chik	do
240	Robusta	Peradeniya, Ceylon
241	Quillon	do
242	Uganda	do
243	Hybrid	do
244	Canephora	do
245	Liberica pasir pogor	do
246	Excelsa	do

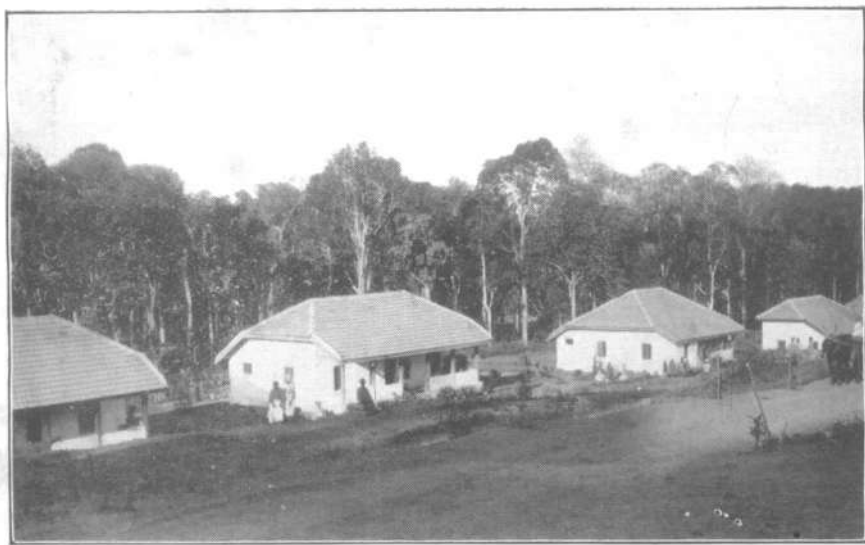


FIG. 2.
View of the Staff Quarters.

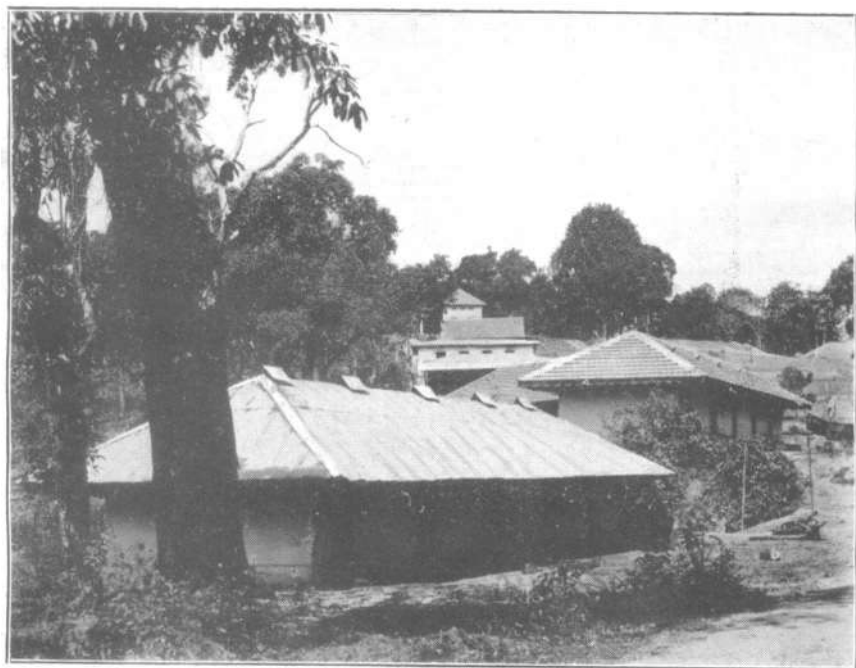


FIG 3.
General View of some of the Coolie Lines.



FIG. 4.

Drake and Fletcher Headland Sprayer in action.



FIG. 5.

Charging a Battery Sprayer (Holder Six No. 1) with the mixture contained in the barrel.



FIG. 6.
Spraying with a Battery Sprayer.



FIG. 7.
Motor Sprayer (Holder), with four long hose attachment,



FIG. 8.

Grafting of Young Coffee Plants in the Nursery. Inverted glass tubes protect grafts from drying.

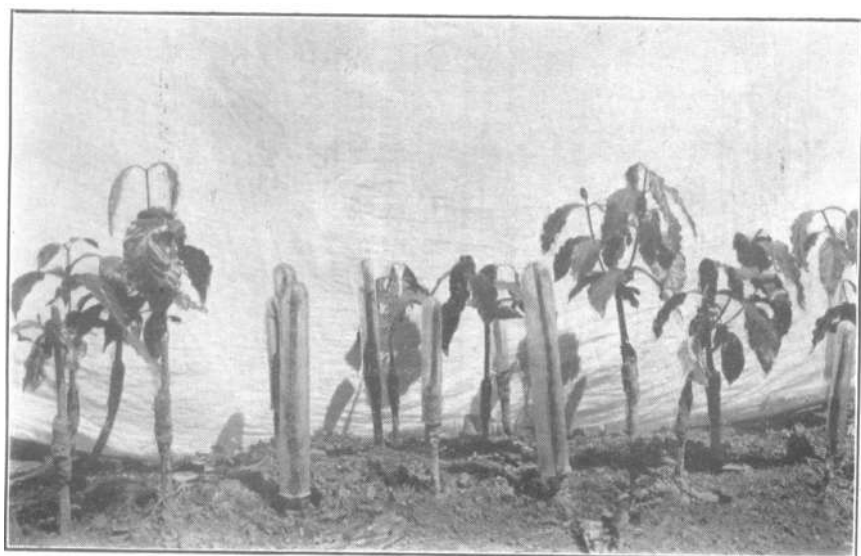


FIG. 9.

Grafted Coffee Plants four months old.



FIG. 10.

General View of a portion of a Coffee Estate thoroughly sprayed.



FIG. 11.

Close View of Sprayed Coffee Bushes. Note the heavy crop and the large number of leaves retained.

The Mysore Coffee Experiment Station—Bulletin No. 8

DEPARTMENT OF AGRICULTURE
MYSORE STATE



REPORT OF WORK ON THE COFFEE
EXPERIMENT STATION, BALEHONNUR

FOR THE YEARS

1930 AND 1931



BANGALORE:
PRINTED AT THE GOVERNMENT PRESS
1932

FOREWORD

AS circumstances have delayed the issue of the Report of the Coffee Experiment Station for the year 1930, it has been thought advisable to publish a combined report for the years 1930 and 1931 thus bringing it as nearly up-to-date as possible. This report also deals with results obtained in the harvest season extending from December 1931 to February 1932.

The report has been prepared mainly by the Manager of the Station, Mr. K. H. Srinivasan, who owing to the tragically sudden death of Dr. M. K. Venkata Rau, has now been placed in charge of all experimental and demonstration work in connection with plantation crops. The report was revised by Dr. Venkata Rau before his death and has since come under revision by myself. The portion dealing with manurial experiments as also the tables of results in this connection have been prepared by the Officiating Agricultural Chemist, Mr. Sampatiengar. Finally, the report contains an account (Appendix I) by Mr. Mayne, Scientific Officer, United Planters' Association of Southern India, of his study of the effect of spraying on leaf fall in coffee and a short note of corrections (*vide* Appendix XI) of Bulletin No. 16, General Series, dealing with *Stephanoderes* in Java.

June, 1932.

LESLIE C. COLEMAN.

REPORT OF WORK ON THE COFFEE EXPERIMENT STATION, BALEHONNUR, FOR THE YEARS 1930 AND 1931.

The following report deals with the work of the Coffee Station from January 1930 to February 1932. The work done during the previous years has been published in Coffee Experiment Station Bulletin No. 3.

Area.—The area of cultivated land now possessed by the station is 82 acres of mature coffee, and 20 acres of young coffee, consisting of selections, hybrid arabicas and other species of coffee. A new plan of the station has been prepared which indicates the situation and extent of all our experimental plots (Plate II).

Rainfall and seasonal conditions.—Rainfall from January to December 1930 was 92·41 inches as compared with 104·05 inches in 1929 and nearly five inches below the average of the last four years. Rain was well distributed between June and October, and was very favourable for planting operations in the estate in general. Both in 1930 and 1931, the blossom showers were timely and plentiful. The rainfall statement from January 1930 to December 1931 is given in Appendix II.

Administration and staff.—There has been no change in the supervision or administrative heads.

As Mr. Young, one of the members of the Advisory Board, resigned in 1931, Mr. A. E. J. Nicholls has been nominated in his place.

The present manager assumed charge of the station on the 1st of June 1930. Besides this new appointment, a laboratory assistant and a trained grafter were also appointed in the same year.

The station maintains 120 to 150 farm labourers including Coast and Mysore coolies. Three labour suppliers are engaged to supply 50 coolies each.

Health of the station and climate.—The climate of the station has been very satisfactory, and extremes of heat or cold have not been experienced. 52·4 degrees is the lowest and 94·7 degrees the highest temperature that

was recorded during last year. From October to December, the mornings are usually foggy.

Malaria is the common scourge of the Plantation Districts and this station is no exception. During the year 1930, there were five deaths among the labour force, but three of these succumbed to diseases which they had contracted before coming to the station. The death rate works out to 26 per 1000 of the population. On the whole, the health of the station is good and compares very favourably with that of the neighbouring estates. Wholesome water is supplied in pipes to all the staff and cooly force. Medicines are stocked and medical treatment is given to the staff and labourers by the Sub-Assistant Surgeon, Balehonnur, who visits the station twice a week.

MANURING EXPERIMENTS.

Old series.—This series consists of experiments with Nitrogenous, Phosphatic, and Potash manures, both artificial and organic, using 25 lbs. N, 37.5 lbs. P_2O_5 and 50 lbs. K_2O to the acre. These manures are tried singly and in combination both in the presence and absence of lime. The availability of different sources of these manures and testing the effects of different combinations of these are also being included. Plate I gives the details and arrangements of experiments. This series of experiments is being conducted since 1925. The crop yields from 1926 to 1932 are furnished in Appendix III.

Manures according to details given in Appendix III were applied during the latter part of 1925 and so only partial effects of such manuring can be seen in the crop of 1926-27 and full effects only from 1927-28 onwards. Thus, we have yields for 5 seasons showing the full effects of manures applied, and average yields for each treatment during the 5 seasons are also given in Appendix III.

In the series dealing with general manurial requirements, the average yields from manured plots for the whole period of 5 years do not show any great appreciable increase over the yield from check plots. The greatest difference is found to be due to the application of Superphosphate in addition to Nitrogen which is 113 lbs. of fruit per acre or nearly 10 per cent over check. When the yields in individual seasons only are taken into account, it is seen, from figures given in Appendix III, that

certain treatments do show appreciable difference in 1928-29 and 1930-31 and they are tabulated below.

Treatment	Yield of fruit in lbs. per acre.	
	1928-29	1930-31
Check	706	771
Only N	809	799
N plus P	814	853
N plus P plus K	970	984

From the above figures, it will be seen that during 1928-29 the completely manured plots have given 264 lbs. or nearly 33 per cent increase over untreated or check plots. Similarly, the increase during 1930-31 has been 213 lbs. or nearly 27 per cent. Effects due to application of only Nitrogen or Nitrogen and Phosphoric acid are not so marked as in the case of complete manure.

As coffee is a plant with a certain periodicity in crop, results of each year cannot be judged separately. Yields from one bumper crop to another may be compared as belonging to one period, and a number of such periods may be grouped together. For the crops under discussion, two such periods have been grouped together.

Since figures for the whole period of five years do not show significant differences between various treatments, it now remains to seek reasons for it. As the manurial plots have been laid out in narrow strips of four rows of coffee plants, it is quite probable that all check plots have been influenced by the side-effects of manured plots. The results of such effects seem to raise the yields of check plots as if they were also partially manured. Similarly, where only one or two plant-foods have been tried, the effects seem to be masked by the influence of other plant-foods applied to neighbouring plots. That the checks have benefited by manures from neighbouring plots is made probable from the fact that yields from these plots in the lean years of 1928-29 and 1930-31 have not been so low as in 1927-28, *i. e.*, just two years after the first application of manures.

The area in which experiments on various doses of a complete manure mixture were located was found to be too full of patches and so the work was transferred to a new plot in 1930. Figures obtained till then have been given and need no comment.

Coming now to the series in which different nitrogenous manures have been applied, it is seen that the results give indications in favour of Sulphate of Ammonia if average yields for the whole period of five years are taken into consideration.

Coming to the trial of various phosphatic manures, figures for the whole period of five years under consideration indicate results in favour of Superphosphate. This indication is fairly marked in the years 1927-28 and 1930-31.

The last series is the one dealing with the trial of Sulphate of Potash and Muriate of Potash. Average yields covering the whole period of five years do not give any indication in favour of either. Results of even individual years do not show anything in particular. Here too, side effects might have masked the actual effects due to individual manures. As Sulphate of Potash is believed to have a good influence on the quality of coffee, its effects are to be looked for elsewhere.

On trying to apply modern statistical methods for an interpretation of results obtained so far, it was found that the lay out of the plots does not admit of application of Fisher's method in interpreting the results. Hence the method of Engledow and Yule has been applied to interpret the figures on hand, and the results of such interpretation are as follows :—

1. Only N plus P has given significant yields over check in the general manurial requirement series.

2. Ammonium Sulphate has given significant yields over check and groundnut cake in the nitrogenous manure series.

3. Single dose and one-and-a-half doses of complete manure have given significant yields over check and double dose in the series dealing with various doses of manure.

4. Superphosphate has given distinctly significant yields over check, steamed bone and raw bone in the phosphatic manure series. Basic slag has given yields just significant over check and bone.

To eliminate side effects as far as possible and admit of an application of modern statistical methods to interpret

results, the experiments are being re-modelled taking in 12 rows for each treatment so that only the 4 middle rows might be taken to study the effects of manures applied.

New series.—(Appendix III A.) In this series, two sets of experiments are being conducted in the new block bought from Mr. C. S. Crawford. In the first set of experiments, we are testing the availability of nitrogen, phosphoric acid and potash in mixtures; variations of plant food ratios from the standard one of $2N$, $3P_2O_5$ and $4K_2O$; and the time of application of general manures. This series also includes the application of general manures at different times and in different doses, *viz.*, full dose before the monsoon; half dose before and half after monsoon; and full dose applied only after monsoon is over.

The second set of experiments in the new series embraces three different blocks lying in different parts of the new estate. In this case, each individual test plot is approximately half an acre in extent. In this set, testing of different sources of N, P and K in different combinations is being tried, but the standard dose here is maintained at 30 lbs. N, 45 lbs. P_2O_5 and 60 lbs. K_2O per acre. Dosage experiments with complete manure consist in applying 10 ozs., 15 ozs., and 20 ozs. per plant.

As these experiments have been newly started in 1930, the results will not be available for some years to come.

Study of soil reaction.—Thirty-six cement cisterns measuring $6 \times 6 \times 1\frac{1}{2}$ feet have been constructed to study the relation of growth of coffee to the Hydrogen-Ion concentration of the soil.

For the purpose of this study, all the cisterns have been filled with soil of the same texture and quality and are planted with coffee seedlings of uniform type. At present, 18 of these cisterns are under treatment although all the 36 are planted up. Acid and alkali is being added at regular intervals to these 18 cisterns to bring them to the required reaction, *i.e.*, 4.5—8.0 PH. The Agricultural Chemist who is conducting these experiments on the station is also conducting similar experiments in pot cultures in Bangalore.

CONTROL OF PLANT DISEASES.

Leaf disease, black-rot, die-back and root-rot are the chief diseases that attack coffee in South India. Spraying

with Bordeaux mixture to mitigate or to eradicate the evil of the first three diseases is being advocated by the Agricultural Department, but no practical remedy has yet been found for root-rot. Mr. Mayne, the Scientific Officer of the U.P.A.S.I., is carrying on scientific investigations on leaf disease, die back, and root-rot. Some of his findings on leaf disease have already appeared in Bulletins Nos. 4 and 6 of the Coffee Experiment Station.

An interesting feature in his investigations of root-rot has been the tracing of root-rot infection to a decaying stump of a shade tree. Assisted by the staff, Mr. Mayne was able to wash the soil under an entire coffee tree over an area of $4 \times 4 \times 4$ feet, thus exposing the entire coffee root system. Fine jets of water under high pressure were used to wash off the soil without causing injury or severing the rootlets.

The results of investigations on black-rot have already appeared in the Departmental Bulletin No. 5, Mycological Series and other publications. Recently, the Officiating Mycologist of the Agricultural Department has been working in the coffee station laboratory and carrying on further researches on black-rot and on fungicidal sprays. The results of these scientific investigations have emphasised the advisability of spraying for the control of these diseases. With this end in view, experiments are in progress (1) to find out suitable sprayers, (2) to test different fungicides and adhesives, (3) to ascertain the most economical strength of fungicidal spray to use, (4) and to study the time or season of applying such sprays to obtain maximum protection with minimum cost.

TESTING OF DIFFERENT SPRAYERS.

Holder power sprayer, Holder battery sprayers, the Drake and Fletcher Headland and the 2 gallon Holder hand sprayer have all been tested and their usefulness and efficiency reported previously in Bulletin No. 3. Two new sprayers, "Vermorel Power" and "Vermorel Headland Sprayer" were recently imported and tested here.

Vermorel power sprayer.—This is a 3 H. P. engine and double cylinder pump mounted on a trolley. It is essentially a single cylinder motor cycle engine, but water cooled. It is designed to take 4 hoses and spray with a pressure of 240 lbs. per sq. inch. Safety devices, air chamber and pressure gauge are all provided. It is wide, heavy and has a very low clearance and as such its

utility in coffee estates is doubtful although the spray obtained at 240 lbs. pressure is very fine. What is needed in a power sprayer for coffee estates is compactness, light weight, simplicity of mechanism and easy portability on estate roads. As this machine lacks all these essential qualities, it is doubtful whether this will ever prove a serious rival to the "Holder Power Sprayer."

Vernorel headland sprayer.—This is a neat little machine, very compact, and is designed to be operated by a single man. It is double acting and has two hose attachments. Being light in weight, it can be easily carried by one man. The quality of spray (using No. 1 jet) is satisfactory but the amount of work got out of this for a work day is just about half that of the Drake and Fletcher sprayer. Further tests will be made with these machines during the next spraying season.

TESTING OF DIFFERENT FUNGICIDES AND ADHESIVES.

Powder dusts have proved throughout ineffective; also they have presented practical difficulties in the way of their application. Hence, these are now discontinued (*vide* Mysore Coffee Experiment Station Bulletin No. 3). Liquid sprays are at present under test using different fungicides and adhesives.

Among the liquid sprays, the following are under test:—

- (1) Casein Bordeaux, (2) Resin Soda Bordeaux, (3) Resin Soda Burgundy, (4) Fish Oil Resin Soap Burgundy, (5) Casein Alum Bordeaux, (6) Linseed Oil Bordeaux with 10, 20 and 40 ozs. of Linseed oil, (7) Solbar and (8) Bordeaux without adhesive.

Casein, resin, fish oil resin soap and linseed oil are used as adhesives or spreaders to enable the spray mixture to adhere properly to the undersurface of the coffee leaf. Casein Bordeaux is more easily prepared than resin soda Bordeaux, but the latter appears decidedly better than casein in its spreading quality. Nevertheless, the difficulty of preparing resin adhesive and the extra cost involved are points worth considering before deciding in its favour. Linseed oil is also used as a spreader and field observations indicate that this material is not inferior in any way either to casein or resin soda in the matter of adhesive properties. Mr. Mayne's observations furnished in Appendix I on the leaf counts to

estimate the effectiveness of the individual sprays also support this view and throw a good deal of light on the merits of different spray mixtures. Further trials are under way and the results will be available after the present crop is harvested and data studied.

From what is said above, one would prefer to select either casein or linseed oil as an adhesive. But linseed oil spray, though it can be prepared much more easily than casein Bordeaux, presents one or two practical difficulties in the field. Since it is a fast drying oil, it forms a thin coating on the inside surface of wooden barrels or other receptacles used for spraying. After a short time, the film gets thickened due to repeated coating and owing to exposure to weather conditions the film gets detached and floats on the solution as small particles or flakes. These find their way into the spray nozzles and clog them. If these are not cleaned immediately, bursting of the rubber hose will result. Further, the labourers do not like linseed oil spray as they get their clothing soiled with oil.

Apart from these difficulties which could be overcome, one must first of all look to the economic side of spraying. Appendix V shows the comparative cost of spraying and of spraying materials per acre. The cost per acre of casein Bordeaux and linseed oil Bordeaux (10 ozs. per 50 gals.) is almost the same. But looking at the yield table furnished as appendix VI, casein Bordeaux plots have yielded the highest crop followed fairly closely by linseed oil Bordeaux (20 ozs. in 50 gals.). Linseed oil at this concentration costs nearly Re. 1-8-0 per acre more than the cost of casein Bordeaux. Therefore, when selecting a spray combination, one should choose the one that presents the least trouble in field practice coupled with a good return. The results up to the present indicate that casein Bordeaux is the most satisfactory combination.

Results of 1931-32 as shown by crop yield.—Further trials are going on and the final and complete results on this series of experiments can only be had after carrying on these experiments for several years. In Appendix VI are given the crop harvest figures for 1931-32 which, on the whole, have shown very satisfactory results. Spraying with Bordeaux and various adhesives has given on the average more than double the crop harvested from the unsprayed control plots. Bordeaux without adhesive has given decidedly poorer results than Bordeaux with adhesives; but this may be partially due to the fact that

these plots had formerly received no effective treatment. Of the adhesives, casein has given the best results followed fairly closely by linseed Bordeaux (20 ozs. per 50 gls.), alum Bordeaux and linseed Bordeaux (10 ozs. per 50 gls.). It is rather difficult to explain why linseed Bordeaux (40 ozs. per 50 gls.) has failed to yield more than or equal to other linseed groups. Resin bordeaux which under laboratory testing has shown superiority over the rest of the adhesives has yielded rather disappointing results. Burgundy also has failed to come up to the expectations and is even poorer than Bordeaux without adhesive.

Strength and time of spraying.—Since spraying on coffee is being gradually taken up by planters, it is of utmost importance to devise means and ways of economy in spraying consistent with effectiveness. With this object in view, experiments are being conducted to study the most economical strength of mixture to use and also the time or times at which the spray must be applied.

In order to test the strength and time of application of sprays, a new set of experiments is in progress. The strength of sprays involves the investigation of the merit of full strength Bordeaux as against half strength and the time of application involving spraying twice in the year, and only once in the year, either before the monsoon or after the monsoon.

The crop picked in this series of experiments during 1931-32 is given in Appendix VII. The indications are that both pre-and post-monsoon sprays are required and that 0.5 per cent Bordeaux might prove quite effective. Some of the control plots have yielded comparatively higher than one per cent or 0.5 per cent pre-or post-monsoon sprayed plots. The reason is that these check plots, namely, 1, 5 and 7 were part of one or other of the treatments when the experiments were first started. Subsequently, the plots were rearranged so as to provide control plots in between each treatment. Before the time of rearrangement, these three plots had the beneficial effect of sprays and therefore the yield in these plots is high. It is expected that the crop figures of the coming year will yield more accurate figures.

Labour requirements and cost of spraying.—The labour force needed with any sprayer depends principally on the nature of water supply. In estates where water has to be transported from a running stream or a tank, a large number of labourers, *i.e.*, 12 to 20 depending upon the

lead is needed to supply one Drake and Fletcher (D.S.P). Double this number is required with a power sprayer. The labour requirements and their cost for the different kinds of sprayers are furnished in Appendix IV. This is based on the practice of the station where water is laid on in pipes to all parts of the estate. Therefore, labour required for transporting water has been excluded in calculating the cost of labour. However, I presume that Re. 0-12-0 to Re. 1-4-0 per day is needed for the cost of water carriage. As regards the working cost of D.S.P. sprayer, it has been found to be advantageous to use two pumps at one centre. This saves one *maistry* and two men labourers and 2 or 3 water coolies. In Appendix IV, working cost of D.S.P. is presented on the above basis. I believe it is quite possible to reduce the labour cost of spraying; but then, this depends upon the temperament of labour and other considerations. Individual practice will suggest possible sources of economy to suit local conditions; hence no hard and fast rule can be laid down regarding allocation of labour. Spraying with the D.S.P. is slightly cheaper than with the power sprayer, but the quality of spray obtained by the power sprayer is undoubtedly better. Appendix V-A gives the total cost of spraying per acre with each of these machines using different spray mixtures either in full or half strength. Depreciation on the value of the machine, etc., is not taken into account. In the same table, the materials required to spray one acre are also shown. In Appendix IV, the capacity of the three principal sprayers is also given. This represents a day's task to the set of coolies engaged, but it is far better to consider the day's work in terms of gallons or barrels of mixture than in terms of acreage. Spraying costs in Appendix V are calculated on the assumption that 400 gallons of the mixture are needed to cover an acre. As stated, great variation in the amount of mixture needed per acre occurs depending upon the kind of coffee bushes one has to deal with; but 400 gallons may be taken as a fair average. The cost of spraying, therefore, depends upon water supply and the amount of mixture consumed per acre.

CONTROL OF INSECT PESTS.

The Entomologist of the Department of Agriculture has been carrying on detailed investigations on the

control of green bug and borer pests on private estates for a number of years, and hence, it is thought undesirable to duplicate this work on the station at least for the time being. Therefore work on the control of insect pests is not undertaken on the station except spraying against green bug and systematic removal and burning of bored coffee plants as part of the estate routine work.

PLANT BREEDING.

The previous report of the station activities (Bulletin No. 3) gives a list of the different strains, varieties and species of coffee which are being tested. These consist of arabica selections obtained from the best estates in almost every coffee growing area in South India, of a very large number of hybrids collected from estates in Mysore, and of robusta and liberica types and sub-types collected in South India and obtained from outside. To these have recently been added selections of *Coffea congesta*, young plants of which are in the nursery. Although the majority of these selections are under three years of age a beginning has been made in further selection and in hybridisation. This latter has been mainly a crossing of promising robusta and hybrid types with Kent.

One of the difficulties in further selection work among hybrids is due to the non-viability of pollen. As the flowering season is very short and as the watering of a large number of plants to bring out the blossom is out of the question, it is necessary to examine plants chosen for selection work long before the blossom showers as to pollen viability. It has been found possible to do this through microscopic examination of flower buds as early as January and to mark out then just which of our hybrids carry viable pollen and so can be self-pollinated. This investigation should greatly assist us in our selection work in the future.

As a result of our plant breeding work of 1930, we have now a considerable number of F_1 generation seedlings growing in the nursery while some have been planted out. In order to avoid an increase in our breeding area these are being planted out to replace selections which have already proved of no value either through lack of vigour, susceptibility to disease or through other undesirable qualities.

Selection and selfing.—Plants are selected with regard to their bearing, vigour and disease resistance. Plants exhibiting such characters are searched for in our selection and varietal plots, and these are selfed or artificially cross-pollinated. In some cases both selfing and artificial fertilising is done on the same plant using different branches or parts of the plant.

Before 1930, paper bags were made use of to cover selfed and crossed flowers. The results were found very unsatisfactory. When these are used, it is found that the growing tips, tender leaves and floral parts are all affected by heat either due to contact with paper surface or due to insufficient aeration. Therefore, wide muslin bags supported inside with bamboo rings were substituted for covering the branches. Figures 1 and 2 show the entire plant and branches being thus covered. These are put on before the flowers open and are removed two or three days after the blossom has set.

During 1929, several plants of arabica and hybrids were selected and the blossoms bagged for collecting pure seeds. Appendices IX and X show the number of fruits collected from selfed and crossed flowers. Among hybrids there was a good deal of failure to set seeds due to lack of fertilisation. This seems to be the case in most of the hybrids. The available seeds were harvested and these are growing in the nursery awaiting transplanting. During the blossom time of 1931, several promising arabicas and hybrids were selected and were bagged for collecting pure seeds. Robusta and other species of coffee have not yet come to the bearing stage, and these will be taken up for similar work later on.

Hybridising.—A safe and satisfactory method of emasculating flowers has been tried and this is found to give very satisfactory results. Instead of cutting away only the anthers by opening the buds, the corolla tube is removed in the unopened stage with the attached anthers leaving the stigma behind. Selected plants are hand watered to force blossom to come out at the required time.

As stated artificial crossing of selected arabicas, such as Kent and Coorg types with robusta pollen is being carried on. Also selected hybrids are pollinated with Kent pollen. The F_1 generation seedlings of the above named crosses have been transplanted into permanent beds. It is noticed that, there is failure to set seeds by

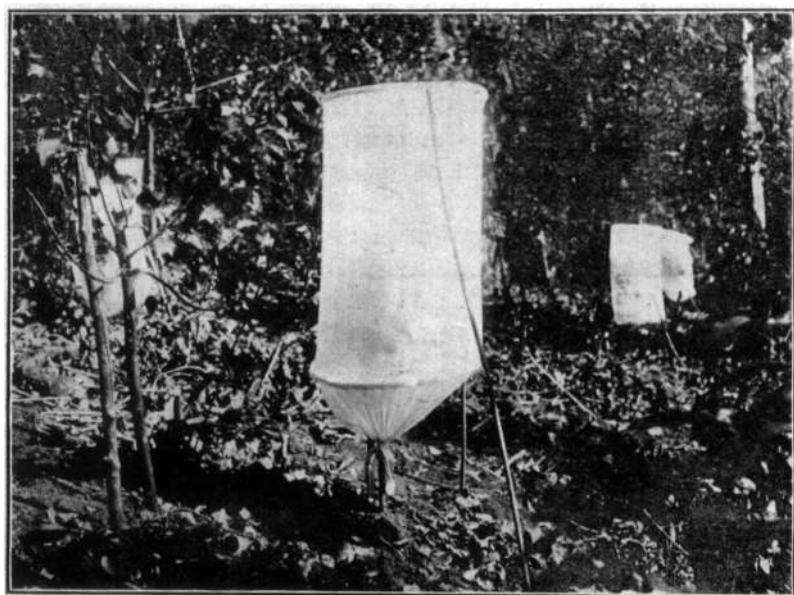


FIGURE 1. YOUNG COFFEE PLANT COVERED BY MUSLIN BAG SUPPORTED WITH BAMBOO RINGS. METHOD OF ISOLATION USED IN SELFING AND CROSSING WORK.

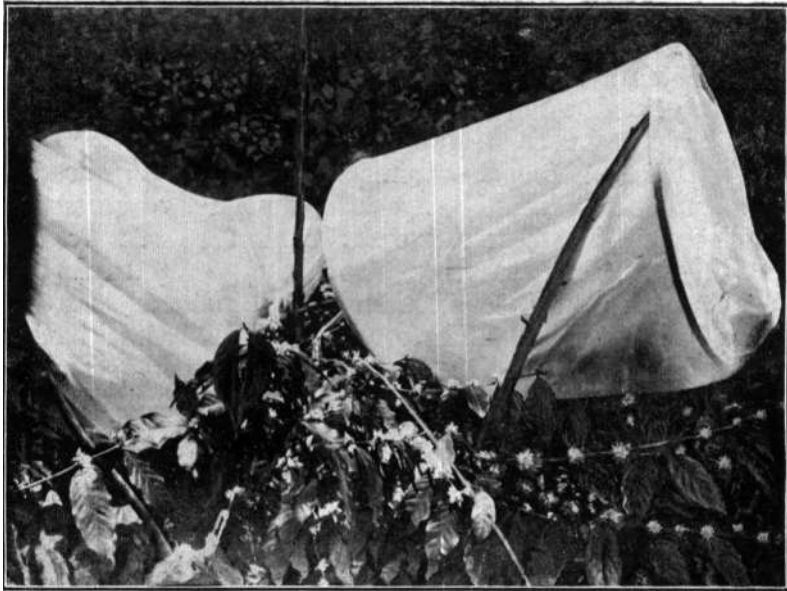


FIGURE 2. BRANCHES OF YOUNG COFFEE PLANT ISOLATED IN MUSLIN BAGS FOR SELFING AND CROSSING.

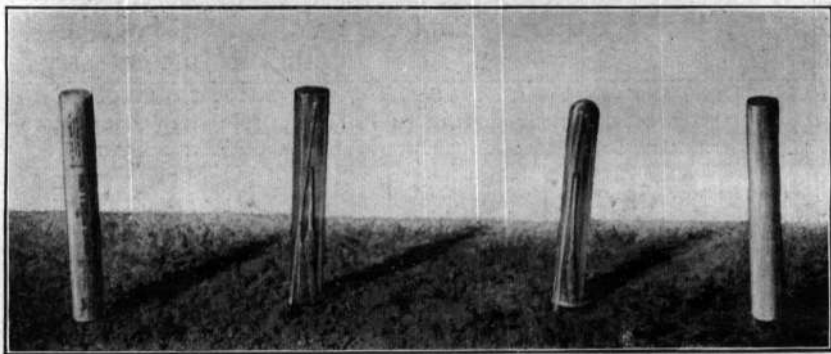


FIGURE 3. GRAFTS COVERED WITH DIFFERENT KINDS OF TUBES. LEFT TO RIGHT:—
NEWSPAPER TUBE DIPPED IN PARAFFIN, XYLONITE TUBE, GLASS TEST TUBE AND
PAPER TUBE DIPPED IN PARAFFIN. .

robustas when crossed with Kents, but when Kents are used as mothers a fair amount of success is obtained. Hybrids artificially pollinated set seeds fairly well, but selfing such plants has till now yielded very poor and in many cases negative results.

Mr. Mayne, the Scientific Officer of the U. P. A. S. I. is making studies in connection with hybridising work. He has been very kindly assisting the station staff in the hybridising and selection work.

Grafting.—Grafting work done prior to 1930 was of a preliminary character to study the performance of grafts and the application of grafting to the coffee industry. The results were very satisfactory, and have led to the appointment of a trained grafter in 1930 to carry on the work regularly and on lines calculated to yield results that are of practical importance.

The programme of grafting work includes the study of the proper time or season for successful grafting, choice of materials, *viz.*, of stock and scion and also the technique of grafting. Besides these, grafting in the field on stumped coffee and robusta supplies is undertaken to study the advantages, if any, over grafting in nursery beds.

Season of grafting.—Since October 1930, systematic grafting work is carried on doing a number of grafts in almost every week throughout the year. The success of grafts, *i.e.*, the number of grafts that have 'taken' is increasing as will be noticed in Appendix VIII which gives the number of grafts done during each month and the success obtained therefrom. So far as the experiments are in progress, the highest number of successful grafts were obtained in the month of June. It is impossible at this stage to state the best season for grafting. Perhaps, we may be able to say with a certain amount of confidence when we have carried on this work for one full year. The correlation of weather data with this work may lead to certain definite conclusions. Local climatic conditions are bound to affect the results of grafting in other places outside this station.

Stocks and scions.—A few grafts have been done using liberica as stocks but robusta is the one mostly used for this work. Our robusta-arabica grafts have been very successful. It is also contemplated to use hybrid arabica stocks especially Netrakonda, which possesses remarkable vegetative vigour and robustness.

Scions are taken from selected arabica suckers. "Chick" coffee suckers are also being used. Some particularly good bearing arabica trees (mother trees) have been marked out to yield suckers and all the side branches of such trees have been cut off in order to force out suckers. The problem of ensuring an adequate supply of suckers for regular and periodical grafting on a large scale presents a practical difficulty. Experiments so far indicate that the best results are secured with brown woody suckers. Nearly four or five months are required to bring the suckers to such a condition and each mother tree can be expected to yield only some 20 good suckers at a time. Hence, it will be realised that either a considerable number of trees must be marked to supply suckers or work must be limited to a few hundred grafts. To solve this difficulty, experiments are in progress to study the possibility of using all the different parts of a sucker. Although woody suckers are found to be the best so far, the middle semi-woody portion of a sucker is also being used. The results are not so satisfactory in this case, and moreover, they are a bit slow in shooting. The very tender part, of the sucker, i.e., the top part, is found to be unsuitable.

Technique of grafting.—The two grafting methods used on the station are wedge and double cleft grafting. As wedge grafting is much the simpler of the two, it is the one largely used here. Even in the matter of security afforded to the scion, the wedge method seems to be just as good as the double cleft. The practical advantage of this method lies in the large number of grafts a grafter can do in a given time.

In usual grafting practice, wax-cloth, binding twine, and clay smear are all used for the care and safety of the grafts; but our experience indicates that wax cloth and clay smear are not necessary. Wedge grafting with twine binding has given us very satisfactory results and the greatest percentage of success from June grafts was obtained by this method. By this rough method, as many as 120 grafts can be done in a single day if suckers are available.

Grafts need to be covered with a suitable covering material to shade them from too much heat and direct sunlight. The tubes are removed as soon as the scions begin to shoot, some time about the 5th or 6th week. In the earlier period of our experiments, glass tubes 9"×1½"

were used. Although the results did not discourage their extended use, the initial cost was very high. Breakages and loss were inevitable, and hence, these had to be given up. Non-breakable xylonite tubes were imported from England, but, unfortunately all the grafts covered with these developed a kind of fungus which inhibited the growth of scions. Hence, new covering material had to be sought for. Newspaper pieces rolled into cylinders and impregnated with paraffin wax both inside and outside were tried with great success. Now, these are exclusively used and the results are very satisfactory. Paper tubes are cheap and cost about $\frac{1}{2}$ th of an anna each and can be made on the estate. The introduction of these has very appreciably reduced the cost of grafting. Figure 3 illustrates the different kinds of covering tubes that have been used.

Nursery grafts and field grafts.—Another means of solving the practical difficulty and reducing expense of grafts is that of grafting in the field. Although grafting in the nursery, has been found a feasible proposition, yet, the extra cost involved in transplanting them to the fields, the loss or retardation due to the seasonal conditions or planting methods, and above all the extra care necessary to raise nursery grafts are points for consideration. The results of our field grafts have been very satisfactory, (Appendix VIII) and in fact the greatest amount of success *i.e.*, 93% as against 76% in the nursery grafts has been obtained in the field grafts done during June 1931. Loss in this method is much less and transplanting difficulties, and extra care and cost are averted.

The practical application of field grafts in estate grassy patches or stump-rot areas is very hopeful, and promises to open up wide possibilities as a method of reclaiming such waste land attached to estates. To study this point further, grassy patches and stump-rot areas have been supplied with robusta seedlings and when these are established, they will be taken up for grafting.

The method of grafting as practised on the station is very simple so that ordinarily intelligent estate coolies can be taught to do it. As a matter of fact, three planters' men were trained in this work in 1930. Since planters are showing a keen interest in grafted coffee, and as they desire to get their men trained in this work, it has been decided to hold on the station short courses to teach grafting.

Short courses on grafting and spraying.—During the year 1931, two courses were held one on grafting and the other on spraying and six men from various parts who were sent over for training by the estate owners were kept on the Farm and taught the work.

CARDAMOM BREEDING.

In the past year, attempts were made to collect available varieties of cardamoms, both upright and trailing kinds to serve the purpose of our foundation stock. We now possess five upright and five trailing varieties collected from cardamom growing districts of Mysore, Bombay and Madras. Seven of these have been planted out in the field. Further collections will be made in the next few years. The existing seedlings will be planted in a suitable locality and the breeding work will be taken up when they begin to bear seeds.

PEPPER.

Besides growing and breeding coffee and cardamom, one other plantation produce, *i.e.*, pepper is also being grown with a view to breed and evolve a suitable variety. At present, cuttings of two varieties, *viz.*, Balankota and Kalluvalli two varieties noted for high yield and quality have been obtained from selected plants grown on the Marthur Farm. Attempts will be made to collect other promising varieties for breeding purposes.

OTHER CROPS.

Green manures.—Fourteen green manure crops were grown in the previous year out of which Boga medalloa (*Tephrosia candida*) *Crotalaria anagyroides*, *Crotalaria usaramocensis*, *Indigofera endecaphylla* and *Vigna oligosperma* have been chosen for growth on a large scale for seed purposes.

Aleurites fordii or *Tung oil*. (*Chinese wood oil*).—The seed of this oil tree has been obtained and planted and as many as 60 plants are growing here. The seeds of this tree yield an oil which is in great demand for high quality varnishes.

FIELD DAY.

A field day and exhibition of work of the station were held on the 26th and 27th November 1931 when

over 400 planters gathered from all parts of the coffee growing areas. The planters were also present at the formal opening of the Laboratory by His Highness the Maharaja of Mysore on the 27th evening. His Highness the Maharaja of Mysore with his staff and the Dewan of Mysore was pleased to camp on the Farm for a period of three days.

On the morning of the 28th instant, His Highness with the party, went round the Farm and inspected all the experimental plots. Spraying with different kinds of sprayers was also demonstrated before His Highness. His Highness showed a keen interest in all the experiments that were under progress.

Visitors. — In addition to His Highness the Maharaja of Mysore, two other distinguished visitors, Sir T. Vijayaraghavacharya and the Hon'ble the British Resident in Mysore visited the Farm. Many coffee planters, both European and Indian have also visited the Farm. The number of visitors is on the increase.

MYSORE COFFEE EXPERIMENT STATION BULLETINS.

No. 1. The Mysore Coffee Experiment Station.—What it is doing for the improvement of Mysore Coffee.

No. 2. The Coffee Berry Borer. (*Stephanoderes hampei*.)

No. 3. Report of work on the Coffee Experiment Station, Balehonnur for the years 1925-30.

No. 4. Seasonal periodicity of Coffee Leaf Disease (*Hemileia vastatrix*, B & Br).

No. 5. Annual report of the Coffee Scientific Officer, 1930-31.

No. 6. Seasonal Periodicity of Coffee Leaf Disease (*Hemileia vastatrix*, B & Br) Second Report.

No. 7. Annual Report of the Coffee Scientific Officer 1931-32.

APPENDIX I.

OBSERVATIONS ON SPRAYING EXPERIMENTS AT THE COFFEE
EXPERIMENT STATION DURING THE YEARS 1930 AND 1931.

In an attempt to supplement the records of crop yield from the various spraying experiment blocks and also to study directly the effect of different sprays and different times of spraying, a series of observations have been carried out in September 1930 and 1931 and, in the case of the time and strength of spray series, also in February 1932. The method employed was to take a number of branch systems of definite type and take counts of the number of growing points and the number of mature leaves. The results were expressed as the number of leaves per growing shoot.

In the case of the small plot experiment series on different types of spray, 20 branches were taken in each of the three plots receiving any given treatment. Inspection showed that these almost always showed a good agreement. The three sets of 20 were taken together and the Standard error of the whole calculated. In the case of the large plot experiments on time and strength of spray, 60 branches were taken at random through each plot, and calculations made in the same way.

1. *Different types of spray.*

The following are the results of the counts made in September 1930 and 1931.—

Mixture used	1930		1931	
	No. of leaves	Standard deviation	No. of leaves	Standard deviation
Linseed Oil Bordeaux 10 ozs. ...	6.35	±.21	6.28	±.23
" " 40 " ...	6.28	±.25	5.77	±.23
" " 20 " ...	6.09	±.19	6.23	±.26
Casein Bordeaux ...	5.90	±.18	6.19	±.24
Fish Oil Resin Soap Burgundy. ...	5.57	±.23	5.66	±.26
Resin Soda Bordeaux ...	5.50	±.16	5.94	±.20
Alum Bordeaux ...	5.38	±.21	6.00	±.28
Resin Soda Burgundy ...	4.87	±.24	5.97	±.21
Solbar 3 per cent ...	3.10	±.11	6.12	±.19
Check. No Spray ...	2.40	±.13	3.13	±.17
Bordeaux without Adhesive ...	...	..	5.40	±.19

While the differences between the majority of the treatments are hardly of statistical significance, Linseed Oil Bordeaux 10 ozs. and Casein Bordeaux both show good results in both years. There is a

APPENDIX.—*concl'd.*

general reduction in differences in 1931 as compared with 1930 and this may perhaps be attributed to the slightly less severity of the disease as indicated by the rather higher count in the checks, which is statistically significant.

Solbar shows itself of little value and has been omitted in later sprays.

The value obtained for spraying without adhesive shows some advantage from the use of adhesive but the difference, in view of the extremely heavy rainfall of August 1931, is not very large.

2. *Time and Strength of Spray.*

These observations were started in September 1931 and repeated in February 1932. The results are given in the accompanying table.

	September 1931		February 1932	
	No. of leaves	Standard deviation	No. of leaves	Standard deviation
1 per cent Spray, May and September	6.55	± 22	4.29	± 17
5 per cent	6.17	± 19	2.45	± 12
1 per cent, Spray, May only	6.39	± 21	2.22	± 14
5 per cent	6.82	± 20	1.67	± 16
1 per cent " September only	3.31	± 21	2.38	± 17
5 per cent " " "	3.34	± 19	2.34	± 15
Check III	2.38	± 19	0.95	± 11
" IV	2.91	± 19	1.48	± 13
" V	3.47	± 23	1.70	± 14

The results are of some interest in suggesting that there is little, if any, difference in effectiveness between the half strength and the full strength spray and also in emphasizing the greater importance of the pre-monsoon spray.

The figures for the February observations have to be interpreted with the crop yield of the different plots in view. Although the leaf amount in the half strength twice sprayed plot is significantly less than that in the full strength twice sprayed plot, it must be borne in mind that the former yielded a very much bigger crop and leaf fall may have been due to this rather than to any reduced effectiveness. Such an explanation, however will not fit the significant difference between the half and full strength May spray only. The difference is not very big but may be due perhaps to the greater reduction in effectiveness of the single spray towards the end of the year which shows itself more clearly with the weaker spray. It will be noted that there is no difference between the two September sprays at any time.

The results from the checks are very variable. This is doubtless due to the residual effects of previous spray treatment which shows itself in the crop figures.

This work is to be continued in the future.

W. WILSON MAYNE.

APPENDIX II.

Rainfall Statement for the years 1930 and 1931

			1930	1931
January	...	...	0'10 Cents	... Cents
February	...	...	...	...
March	...	...	0'83	1'50
April	...	...	2'41	7'02
May	...	...	4'93	3'11
June	...	...	16'86	10'44
July	...	...	25'76	24'67
August	...	...	17'34	49'88
September	...	...	12'05	8'85
October	...	...	10'42	1'45
November	...	...	1'71	3'88
December	...	...	...	0'69
Total	...	...	92'41	111'49

Highest rainfall on a single day 6'98 in 1926.

" " " 4'95 in 1930.

Average of four years. 98'44 cents.

Meteorological data of the Coffee Experiment Station, Balehonnur.

	1930				1931			
	Max. Temp.	Min. Temp.	Mean of Max. and Min.	Humidity percentage at 8 A.M.	Max. Temp.	Min. Temp.	Mean of Max. and Min.	Humidity percentage at 8 A.M.
January	82	59	71	73	82	60	71	70
February	83	60	72	72	87	61	74	80
March	89	63	76	81	89	64	77	73
April	89	66	78	82	88	68	78	86
May	85	66	76	89	86	67	77	84
June	78	66	72	86	78	67	73	83
July	73	66	70	93	75	66	71	90
August	74	75	70	92	73	66	70	92
September	77	65	71	92	76	65	70	96
October	80	65	72	92	79	64	72	85
November	79	61	70	91	78	61	69	90
December	81	60	71	83	80	63	72	79

APPENDIX III.
YIELD STATEMENT OF COFFEE MANURIALS.
18 ACRE BLOCK 1926 TO 1932.
General Manurial Requirements.

Sl. No.	Treatment	Yield in lbs. of Green berries per acre						Average error of from 1927-32 mean	Probable error of mean
		1926-27	1927-28	1928-29	1929-30	1930-31	1931-32		
1	Check	...	...	...	...	...	...	1189	± 213
2	Groundnut Cake. (N)	2313	584	706	1718	771	2164	1189	± 208
3	Super (P)	2256	547	809	1925	791	2008	1217	± 199
4	Polash (K)	2530	610	950	1816	835	2115	1265	± 180
5	N plus P	2327	650	748	1737	746	1855	1147	± 215
6	N plus K	2518	684	814	2064	853	2098	1302	± 229
7	P plus K	2336	591	673	2027	735	2128	1250	± 194
8	N plus P plus K	2396	499	607	1683	984	1866	1078	± 178
		2554	607	970	1691		2050	1260	
Standard deviation of differences between comparable plots = 117.3 Standard error of mean difference = 52.4									
Nitrogenous Manures.									
9	Check	...	...	...	...	...	...	1120	± 175
10	Groundnut Cake	2068	601	834	1154	912	2097	1217	± 178
11	Ammonium Sulphate	2138	476	1071	1192	1222	2125	1366	± 201
12	Nicifos*	2484	782	914	1460	1309	2464	...	...
13	Sodium Nitrate†	...	...	...	1195	1148	2160	...	...
		...	...	...	1200		2451	...	...

* Nicifos 17.45 was used in place of Floraid from 1929-30

† Sodium Nitrate was used in place of green manure from 1928-29

APPENDIX III-A.

NEW MANURIAL BLOCK 1929-32.

Mixtures and reinforcement of manures.

Sl. No.	Treatment	Average yield of green berries in lbs. per acre		
		1929-30	1930-31	1931-32

I. Series.

1	Check ...	1088	555	1788
2	Cake, Super, and K_2O ...	1211	774	1875
3	Am_2SO_4 , Super and K_2O ...	1304	829	2004
4	Cyanamide, Super and K_2O ...	1264	678	2079
5	Nitrate of Soda, Super and K_2O ...	1078	873	1717
6	$\frac{1}{2} Am_2SO_4$, $\frac{1}{2} NaNO_3$ Super and K_2O .	1123	847	1625
7	$\frac{1}{2}$ Cake, $\frac{1}{2} Am_2SO_4$, Super and K_2O	1055	843	1650
8	$\frac{1}{2}$ Cake, $\frac{1}{2} NaNO_3$, Super and K_2O .	1133	782	1525
9	$\frac{1}{2}$ Cake, $\frac{1}{2} Am_2SO_4$, $\frac{1}{2} NaNO_3$, and Super and K_2O .	1238	673	1666
10	$\frac{1}{2}$ G. N. Cake, $\frac{1}{2}$ Castor Cake, $\frac{1}{2}$ Bone, $\frac{1}{2}$ Super and K_2O .	1109	594	1744

II. Series.—Variation of plant food ratios.

1	Check ...	980	403	1834
2	25 lbs N, 37.5 lbs. P, and 50 lbs. K. (2 : 3 : 4.)	1125	427	1880
3	50 lbs. N, 37 lbs. P, and 50 lbs. K. (4 : 3 : 4.)	1190	450	1716
4	25 lbs. N, 50 lbs. P, and 50 lbs. K. (2 : 4 : 4.)	1355	376	1891
5	25 lbs. N, 37.5 lbs. P, and 75 lbs. K. (2 : 3 : 6.)	983	391	1481

III. Series.—Time of application of manures.

1	Check ...	1149	473	1877
2	Complete manure after monsoon...	1202	588	1892
3	Do before monsoon ...	1252	523	1590
4	Complete $\frac{1}{2}$ dose each time ..	1579	562	1729

IV. Series.—Varying doses of mixtures.

1	Check ...	1006	431	1803
2	Single dose ...	1165	559	1658
3	One and half dose ...	1131	405	1791
4	Double dose ...	1322	322	1487

APPENDIX IV.

Cost of labour for working the three kinds of sprayers, as per Coffee Station practice and 400 gallons per acre basis.

	Power Sprayer, 3 acres per day 1,200 gallons			Drake and Fletcher 2½ acres per day 1000 gallons, using 2 D. S. P.'s at one centre			8-Two gallons Hand sprayers 1 acre per day 400 gallons		
	Total No.	Rate of wages	Labour cost	Total No.	Rate of wages	Labour cost	Total No.	Rate of wages	Labour cost
Attendant ...	1	Rs. a. p. 0 8 0	Rs. a. p. 0 8 0	...	Rs. a. p. ...	Rs. a. p. ...	...	Rs. a. p. ...	Rs. a. p. ...
Maistry ...	1	0 8 0	0 8 0	1	0 8 0	0 0	1	0 8 0	0 8 0
Male coolies ...	8	0 5 0	2 8 0	10	0 5 0	2 0	9	0 5 0	2 13 0
Female coolies ...	6	0 3	1 2 0	6	0 3 0	1 2 0	3	0 3 0	0 9 0
Commission on the wages of coolies.	...	10%	0 5 10	...	10%	0 6 10	...	10%	0 5 5
Fuel consumption, etc. ...	...	...	2 15 5*	...	...	0 5 3†	...	...	...
Total ...	...	Per acre 2 10 0	7 15 3	...	Per acre 2 3 3	5 8 1	...	Per acre 4 3 6	4 3 5

* Fuel consumption for the power sprayer.

Rs. a. p.

1½ gallons petrol for a working day of 5 hours ... 2 3 5
30 ozs. of Mobile Oil ... 0 10 6
Cotton waste and grease, etc. ... 0 1 6

Total ... 2 15 5

† For D. S. P. Sprayer.

Rs. a. p.

Grease, etc. ...

Rs. a. p.

0 5 3

APPENDIX V.

Cost of spraying per acre with various kinds of sprayers, and mixtures in varying doses.

Formula :—

400 gallons of mixture per acre.

Full strength. ... 5 50 1 per cent.
 Half " ... 2½ 50 ½ per cent.

Kind of spray	Adhesive group in lbs. per acre					Chemicals group in lbs. per acre				Total cost of materials per acre including adhesive	
	Resin in lbs	Casein in lbs	Linseed oil in ozs	Fish oil soap in lbs.	Copper sulphate in lbs.	Lime in lbs.	Alum in lbs.	Soda Ash in lbs.	1 per cent	½ per cent	
1	2	3	4	5	6	7	8	9	10	11	
1. Casein Bordeaux	...	8	...	...	40	40+8	...	...	13 14 0	7 10 0	
2. Resin Bordeaux	16	...	...	...	40	40	...	4	15 4 0	9 2 0	
3. Linseed Bordeaux 10 ozs	...	...	80 ozs.	...	40	40	...	...	13 14 0	7 12 0	
4. Resin Burgundy	16	...	...	...	40	...	...	22+4	14 15 0	8 14 6	
5. Fish Oil soap Burgundy	...	...	...	16	40	...	...	22	16 1 0	10 0 6	
6. Alum Bordeaux	...	8	...	...	16	20+8	16	...	...	8 10 0	
7. Bordeaux Plain	...	...	...	...	40	40	...	...	12 6 0	6 4 0	

*In the half strength mixture, the quantity of adhesive used is the same as in 1 per cent.

APPENDIX V-A.

Kind of spray	Holder power sprayer. Cost per acre, materials plus labour 2 10 0 <i>Vide</i> App. IV.				Drake and Fletcher Sprayer. Cost per acre, materials plus labour 2 3 3 <i>Vide</i> App. IV.				8 Two gallon Hand sprayers cost of materials plus labour 4 3 6 <i>Vide</i> App. IV.				Remarks
	1 per cent				1 per cent				1 per cent				
	12	13	14	15	16	17	18						
1. Cassin Bordeaux	16 8 0	10 4 0	16 1 3	9 14 9	18 1 6	11 13 6	11 13 6	Add 12 annas to lie. 1-4-0 for water supply. This will give the total spraying cost. The water lead assumed here is between 500-600 yards.					
2. Resin Bordeaux	17 14 0	11 12 0	17 7 3	11 6 9	19 7 6	13 5 6	13 5 6						
3. Linseed Bordeaux 10 ozs	16 8 0	10 6 0	16 1 3	10 0 9	18 1 6	11 15 6	11 15 6						
4. Resin Burgundy	17 9 0	11 8 6	17 2 3	11 3 3	19 2 6	13 2 0	13 2 0						
5. Fish oil soap Burgundy	18 11 0	12 10 6	18 4 3	12 5 3	20 4 6	14 4 0	14 4 0						
6. Alum Bordeaux	.....	11 4 0	.....	10 14 9	.....	12 13 6	12 13 6						
7. Bordeaux Plain	15 0 0	8 14 0	14 9 3	8 8 9	16 9 6	10 7 6	10 7 6						

RATES OF MATERIALS.

1. Copper sulphate	Rs. 25 8 9 per Cwt.	5. Lime	Rs. 1 10 0 per tin or 0 1 0 per lb.
2. Resin	.....	6. Alum	.....
3. Casein	.....	7. Fish oil soap	.....
4. Soda ash	.....	8. Linseed oil 80 ozs.	.....

APPENDIX VI.

VARIETAL SPRAY EXPERIMENTS.

ABSTRACT OF YIELD OF COFFEE FOR 1931-32.

Abstract arranged in the descending order of efficiency taking the yield of different treatments into consideration.

Sl. No.	Treatment	Number of treatment	Number of yielding plants	Total yield		Average yield		Average yield per unit plot of 80 plants		Per acre 1200 plants	
				Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.	Lbs.	Ozs.
1	Cas. Bordeaux ...	3	212	539	2	179	11	203	7	3051	9
2	Lin. Bordo, 20 Ozs. ...	3	219	517	7	172	6	189	0	2835	0
3	Alum Bordo ...	3	203	466	8	165	8	183	13	2757	3
4	Lin. Bordo, 10 Ozs. ...	3	224	496	6	165	7	177	4	2658	12
5	Resin Bordo ...	3	227	487	5	162	7	171	11	2575	5
6	Lin. Bordo, 40 Ozs. ...	3	226	458	10	152	14	162	6	2434	11
7	Bordo No adhesive ...	3	212	385	10	128	9	145	8	2182	8
8	Resin Burgundy ...	3	210	370	10	123	9	141	3	2117	13
9	F. O. R. S. Burgundy ...	3	186	280	0	93	5	120	7	1806	9
10	Check ...	11	714	685	13	60	8	74	10	1119	6
11	Solbar ...	3	218	170	11	56	14	62	10	939	6

*Discontinued since post monsoon and changed to Burgundy without an adhesive.

APPENDIX VII.

CROP YIELD IN TIME AND STRENGTH OF SPRAY BLOCKS 1931-32.

Sl. No.	Treatment	Total No. of plants including non-bearing and supplies	No. of yielding plants only	Total yield in the plot	Yield per 500 plants unit
				Lbs.	Lbs.
1	Check ...	514	438	1436	1639
2	Pre-and Post-1% ...	1705	1358	3871	1425
3	Check ...	502	371	548	738
4	Pre-1% ...	1744	1366	2768	1013
5	Check ...	523	384	1405	1829
6	Pre-and Post-0.5% ...	1700	1322	5446	2059
7	Check ...	485	288	593	1026
8	Pre-0.5% ...	1681	1104	1786	809
9	Check ...	500	351	468	667
10	Post-1% ...	1723	1357	2166	800
11	Check ...	514	375	499	666
12	Post-0.5% ...	1631	1355	2310	852
13	Check ...	546	426	612	715

APPENDIX VIII.

Percentage of successful grafts during each month.

1 Nursery			2. Field			per cent age of success of 1 and 2
Month	No. of grafts made	No. successful	Month	No. of grafts made	No. successful	
October	144	1	October	...	...	1
November	111	38	November	...	28	38
December	144	60	December	...	...	42
January	337	179	January	...	...	53
February	40	28	February	...	6	74
March	47	32	March	...	13	75
April	70	35	April	...	55	52*
May	256	184	May	...	6	73
June	150	114 (76%)	June	...	120	84
Total	1269	670	Total	...	228	182

*During this month, mostly green and tender suckers were used.

APPENDIX. IX.

Statement showing the results of "Selfing and Hybridising" Coffee during 1929 and 1930.

Selfing in 1929-30				Crossing in 1929-30		
Varieties	No. of berries	No. of seedlings surviving for field observation	Varieties Mother plant	Pollen	No. of berries	No. of seedlings surviving for field observation
1. Parent of "Kent"	3	...	1. Menth G. D. (S. 8)	K. "Kent" ...	7	1
2. Netraconda Hybrid	110	24	2. Netraconda Hybrid (S. 2)	Do ...	19	3
3. Do	33	12	3. Kumergod Hyb. (S. 7)	Do ...	16	2
4. K. "Kent"	31	2	4. K. Kent (S. 20)	Robusta ...	32	10
5. Do	12	4				
6. Do	77	26				
7. Do	59	9				
8. Coorg	124	43				

APPENDIX. X.

Statement showing the result of "Selfing and Hybridising" Coffee during 1930-31.

Selfing in 1930-31			Crossing in 1930-31			
Varieties	Seeds sown	Seedlings existing	Varieties	Pollen	Seeds sown	Seedlings existing
1. Kumergod S. 7	19	13	1. Kumergod S. 7	Kent ...	6	6
2 Golden drop S. 9	120	73	2. Golden drop S. 8	Kent ...	22	12
3. Netraconda Hybrid S 10	4	3	3. Do S. 9	Kent ...	98	75
4. Do S. 11	3	2	4. Kent. (behind quarters ii. row S. 23)	Robusta ...	85	68
5. Kent S. 16	21	19	5. Netraconda Hybrid S. 24	(1) Kent ...	34	24
6. Do S. 18	42	28	Do	(2) Robusta ...	10	5
7. Do S. 19	26	23	6. Handi-Kent S. 25	Robusta ...	2	2
8. Doobla Hybrid S. 26	203	79				
9. Bunch bearing Bicoode S. 28	33	28				

APPENDIX XI

**Letter No Roc. 1121 Sc. 151 of 31-32, dated 16th January 1932, from the Director of Agriculture in Mysore, Bangalore to the Editor, Planters' Chronicle, Madras.*

Dr. S. Leefmans, Chief of the Institute for Plant Disease, Department of Agriculture, Buitenzorg, Java, has drawn my attention to a misstatement in my Report on the Coffee Berry Borer. On page 16 of this report, I have stated that samples of seeds have been received here from Java accompanied by a certificate of fumigation and these seeds were found badly infested with insects.

Dr. Leefmans has pointed out to me that the certificate sent with this seed was not a certificate of fumigation but of inspection. On looking up the typewritten certificate received, I now find that the word 'fumigated' has been crossed out with a pencil. This slipped the attention of Dr. Badami who first reported the matter to me and I also overlooked it in hurriedly going through the certificate at the time it was received. I very greatly regret this error of statement on my part.

Dr. Leefmans in his letter to me indicates that he sees in my remarks a severe criticism of the fumigation section of his institute. This was not intended. All I wished to point out was the danger of accepting fumigation certificates whatever their origin and the impossibility of guaranteeing that seed imported under a fumigation certificate is free from insect pests. I have a very high admiration for Dr. Leefmans and the work being done in the Institute of which he is the head. If the remarks made by me in my report have led readers to think otherwise, I wish to correct any wrong impression created.

* The letter above was published in the Planters' Chronicle, Vol XXVII, No. 3, dated 30th January 1932 and is published here to give the correction greater publicity.

The Mysore Coffee Experiment Station—Bulletin No. 7.

DEPARTMENT OF AGRICULTURE
MYSORE STATE



ANNUAL REPORT OF THE COFFEE
SCIENTIFIC OFFICER, 1931-32

BY

W. WILSON MAYNE, B.Sc.

*Scientific Officer to the United Planters'
Association of Southern India*



BANGALORE:
PRINTED AT THE GOVERNMENT PRESS
1932

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FOREWORD

FOR reasons similar to those of last year, it has been considered desirable to publish the report of Mr. Mayne's work during 1931-32 also, as a bulletin of the Mysore Coffee Experiment Station. The Executive Committee of the United Planters' Association of Southern India have kindly consented to this arrangement.

BANGALORE, }
20th July 1932 }

H. V. KRISHNAYYA,
Offg. *Director of Agriculture*
in Mysore.

ANNUAL ADMINISTRATION REPORT OF THE COFFEE SCIENTIFIC OFFICER, 1931-32.

I have the honour to present the administration report of the Coffee Scientific Officer for the year ending 31st March 1932, dealing with the work in progress in connection with coffee problems.

As in previous years, the work has been centered at the Mysore Government Coffee Experiment Station, Balehonnur, under the direction of Dr. L. C. Coleman. Work in co-operation with the officers at the Station has been continued in connection with breeding, spraying and miscellaneous problems.

In November 1931, it was decided to employ an Indian assistant to work on the problems of Mealy Bug and Cockchafer in S. Coorg. Mr. V. K. Subrahmanyam, B.Sc. was appointed to the post at the commencement of December and after six weeks training in the Entomological Section of the Mysore Department of Agriculture, Bangalore, took up his duties in S. Coorg, with headquarters at the former Coffee Experiment Station at Siddapur.

The report comprises, as usual, a short account of touring work, scientific investigations in progress and general notes on coffee problems which have been raised during the year.

Touring.—Two periods of absence from headquarters have been occupied with visits to other districts. A period of one month in July 1931 was spent in S. Coorg in connection with Mealy Bug and Cockchafer the work of which will be considered under that heading later in the report.

In January 1932, a further period of one week was spent in S. Coorg in order to lay down lines of work for the Entomological Assistant. Following this, a short visit was paid to the Nilgiri-Wynaad to investigate an obscure root disease reported from an estate in that district. A report embodying the results of the investigation was prepared and despatched to the estate in question. The

points of general interest in connection with this root disease will be considered in the section dealing with root diseases.

INVESTIGATIONS.

Leaf Disease—Progress Report.—Considerable time has been occupied during the year with investigations directed to increase the available information on the life history, mode of infection and distribution of Leaf Disease (*Hemileia vastatrix* Berk. and Br.) and of the phenomena of resistance shown by various individual plants and strains. In some directions, progress has been satisfactory; in others, certain preliminary difficulties have not yet been completely overcome. The work falls into four parts—spore germination, infection, spore distribution and phenomena of resistance and susceptibility. In addition, evidence from field observations undertaken for studies of spraying and fruit loss has helped to shed further light on the problems of the rise and fall of attacks.

1. *Spore Germination.*—The germination of the Leaf Disease fungus spore is the first step in the development of a Leaf Disease spot and it is also the period during which the fungus is most vulnerable to direct measures of control. It will, therefore, be clear that an understanding of the process and the factors which influence it is of very considerable importance in increasing our control over the disease.

Most of the time up to date has been occupied with elaborating suitable technical methods of studying germination under various conditions. Increasingly more satisfactory results have been obtained, but even yet they leave much to be desired. Until the methods are sufficiently accurate to provide similar results in experiments carried out under similar conditions, it is not possible to study the effect of varying the conditions and so far this requirement has not been realized. The following figures illustrate the difficulty. These (Table I) are the percentage germinations found in 12 drops of distilled water containing spores which had been preserved in tubes for four days. The drops were distributed on four glass slides, each enclosed in a small closed dish. The conditions in each dish were considered to be identical as to humidity and temperature and all the glass ware had been cleaned and sterilized in the same way. The spores were all collected

from the same infected leaf from spots of approximately the same age by allowing the ripe spores to drop on a sheet of white paper.

TABLE I.

*Percentage germination of Hemileia spores
preserved for four days.—*

Slide.	Percentage germination	Slide.	Percentage germination
Slide 1.	22'5 per cent	Slide 3.	18'3 per cent
	22'5 "		21'5 "
	17'0 "		25'8 "
Slide 2.	34'8 "	Slide 4.	44.0 "
	48'3 "		33'5 "
	37'3 "		42'0 "

It will be seen that the degree of variation is very high, ranging from 17'0 per cent to 48'3 per cent. It is to be noted that drops on the same slide show fairly close correspondence except in the case of slide 2, and that the slides 1 and 3 correspond fairly well as also do slides 2 and 4. This suggests that there is some factor of variation between slides or the dishes enclosing them which has upsetting results, and so far this factor has eluded detection.

In spite of these difficulties, information of a fairly definite character has been obtained on two points in connection with the germination of *Hemileia* spores. These two points have a direct bearing on field problems.

The first point concerns moisture conditions for germination. It has been found that germination does not occur in the absence of liquid water, but that actual submersion in water has a depressing effect on the development of germ tubes. The most favourable conditions are provided when dry spores are dusted on to drops of water. This has an interesting bearing on the view expressed in the reports on the Seasonal Periodicity of Coffee Leaf Disease (Mysore Coffee Experimental Station Bulletins 4 and 6, 1930 and 1931) that the rate of increase of the disease is retarded under heavy rainfall conditions. Under such conditions, spores would soon be waterlogged and therefore in an unfavourable condition for germination and this,

together with the washing effect of heavy and continuous precipitation would account for the behaviour already deduced from field observations.

The second point concerns the effect of light. It has been found that light has an inhibitory action on germination. The figures for two experiments given in Table II illustrate this point.

Experiment 1 was carried out with drops of water inoculated with spores on leaf surfaces from which the drops were afterwards removed to slides and counts made. Experiment 2 was carried out on glass slides. Similar results were obtained in other experiments. In these experiments, dry spores were dusted on to drops of distilled water.

TABLE II.

Effect of light on the Germination of Hemileia Spores.—

Experiment	percentage germination.	No. of drops examined
1. Light (N. window)	0.0 per cent	4
" "	0.0 "	4
Darkness ...	16.3 " (mean)	6
" "	14.5 " "	4
2. Light (N. window)	2.0 " "	3
" "	1.2 " "	3
Darkness ...	49.2 " "	3
" "	38.1 " "	3

This effect of light is at variance with most of the previously recorded work on the germination of rust spores but is in agreement with some results recently recorded by Dillon Weston for the spores of Black Stem Rust of wheat.

The problem requires much further investigation and work is planned to study the bearing of this laboratory discovery on the behaviour under natural conditions.

It at once focusses attention on night times as the period of spore germination. It does not seem to have much bearing on the question of shade, however. All the

experiments so far done have been under light conditions from a N. window, but some evidence from inoculation experiments suggests that diffuse light has not the same inhibitory effect.

The possibility of conditions favourable for infection being best realized at night and the results of experiments on the moisture requirements for germination served to indicate the highly favourable conditions presented by heavy morning dew. This commences in darkness and provides more efficiently than any shower of rain, a covering of innumerable fine drops of water over both surfaces of the leaf.

Judging by general observations in the field, the amount of heavy mists and dew occurring during the rainless months determines, to a great degree, the severity of the annual Leaf Disease attacks.

A large number of experiments undertaken to study the effect of short periods of storage of spores on their ability to germinate gave doubtful results for the reasons already described. There is some suggestion that a short period of storage of spores, sufficiently mature to fall from leaves kept in still air, results in better germination than is given by spores placed directly on water drops after detachment from the leaf.

Attempts to estimate the length of time which spores would retain their ability to germinate were commenced but beyond the fact that two collections kept in sealed tubes at laboratory temperatures and medium humidity gave no germination after six weeks, no reliable results have been obtained as to the limits.

2. *Infection of Coffee Leaves by Hemileia vastatrix.*—References in earlier reports to experiments on artificial inoculations of Leaf Disease were all records of failure, but during 1931, successful results were obtained and a technique of inoculation worked out. It is now possible to obtain inoculations on detached coffee leaves and to retain such leaves healthy for periods up to two months, giving ample time for the complete cycle from spore to spore to be completed and to allow studies on the type of infection and amount of spore production to be made.

The failure of the early experiments must be attributed to ignorance of the part played by light in inhibiting germination of spores and to insufficient control of the acidity of the water used for the inoculation drops.

The results so far obtained are of considerable interest but there remains a wide range of doubtful points which require clearing up.

Considerable variation in the time required for the development of visible spots at the places of inoculation and for the commencement of spore production was found in various experiments. Even separate inoculations on the same leaf showed differences of several days in these respects. The judgment of these times, particularly those of the first appearance of pale spots, is very difficult as the number of successful penetrations per unit area influences visibility. Taking the results as a whole, it appears that from 7 to 12 days elapse between infection and the first appearance of a yellow spot and from 15 to 24 days between infection and the first appearance of spores. These figures refer to Coorg variety leaves infected with spores taken from Coorg leaves and the experiments were conducted under laboratory conditions of temperature under glass jars. Inoculation on susceptible Robusta leaves gave much longer periods for the development of a visible spot and of spores, a matter of some interest with respect to the future status of *Hemileia* as a disease of Robusta.

TABLE III.

Leaf Disease Infection Times.

Date	Leaves	Origin of Spores	First appearance of	
			Yellow spot	Spores
8-10-31	Coorg	Coorg	12 days	15 days
28-10-31	"	"	8 "	16 "
6-11-31	"	"	9 "	17 "
14-12-31	"	"	5 "	17 "
12-1-32	"	"	7 "	24 "
12-1-32	"	"	7 "	22 "
12-1-32	"	Robusta	7 "	24 "
12-1-32	Robusta	"	20 "	29 "
12-1-32	"	Coorg	20 "	35 "

Of the factors which may affect the times required for the appearance of infection and of spore production, the following will require consideration—temperature, age of leaf, humidity of the air during development and the density of infection. It must be noted that the later infections in Table III were carried out on more mature leaves than the earlier ones owing to the cessation of vegetative growth and the difficulty of obtaining more tender leaves.

It is considered that the first appearance of pale spots is an unreliable index of the rate of development, as it depends very greatly on the person examining the leaf. The first date of spore formation is a much more well defined point in the life history.

3. *Resistance and Susceptibility*.—The development of a method of obtaining infections in the laboratory opened up a wide field of work in investigating the behaviour of the numerous selections, hybrids and crosses which are available at the Experiment Station. Work along these lines was started in September and the results have been of great interest and importance in relation to the breeding and selection work.

The first experiments were carried out on a number of plants which had been previously selected for their vigour and disease resistance as suitable starting points in the development of improved strains. The first experiment included leaves from four highly resistant plants which showed no disease in the field, two moderately resistant plants with some disease and one common Coorg type. Four leaves from each tree were inoculated and kept in the laboratory and the reaction of the plants recorded. The spores used came from Coorg trees.

Two striking results were obtained. The leaves from the four highly resistant plants showed this character in the experiment, but there was ample evidence that their resistance did not depend on any inability of the fungus to penetrate, because in the areas inoculated minute pale yellow spots developed, similar in appearance to the initial yellow spots which appear on ordinary susceptible plants. These yellow spots did not develop any further and although the leaves were kept under observation for 32 days, no spore production took place. Within that period, the Coorg leaves had developed disease spots and produced spores. Similar results were obtained in a

second experiment carried out for confirmation. The study of the internal changes associated with the development of these abortive infections is to be taken up.

The second point arose from the results obtained with one of the two moderately susceptible trees. This set of leaves inoculated in the same way as the rest behaved like the completely resistant sets, although in the field the tree from which they came showed some development of ordinary spore producing disease spots. An experiment was at once started to study the result in more detail. Leaves from this tree—S. 5-30 in the Station records—were inoculated on one side of the midrib with spores collected from a Coorg tree, such as had been used in the previous experiment described and on the other side with spores from S. 5-30. A control series was started at the same time using leaves from a Coorg tree inoculated in the same way.

The Coorg leaves showed the development of typical disease spots on both sides of the midrib, *i.e.*, both collections of spores were equally capable of infecting the leaves. On the S. 5-30 leaves, however, only the side inoculated with spores collected from S. 5-30 leaves showed the development of spore producing disease spots. The side inoculated with spores collected from a Coorg tree failed to produce more than pale spots which never developed into spore-producing pustules. These results have been repeatedly confirmed for the selection S. 5-30. Similar results were obtained with a set of leaves from a Kent tree which was resistant to spores collected from a Coorg tree and susceptible to spores from infections found on the Kent. A further experiment in which leaves from this Kent tree were inoculated with spores collected from S. 5-30 and with spores from the Coorg revealed that the Kent behaved in the same way as S. 5-30 in its reaction to the different spore collections.

It is considered that these experiments establish the existence of two strains of *Hemileia vastatrix* which behave differently on certain strains of *Coffea arabica*.

There is a strong suggestion that this resistance to one strain is common among Kent's selection. S. 5-30, on which this behaviour was first found, is grown from seed of a plant in Woger estate which is related to Kent. Further, the results afford a basis for the explanation of features in the field behaviour of Kents which have

previously been inexplicable. An account of this work in relation to the behaviour of Kents has been prepared and will be published in the "Planters' Chronicle."

Much further work is required on this problem to investigate what proportion of Kent plants possesses this partial resistance and how it is inherited. There is also the possibility of still other strains of the disease, though no certain evidence has as yet been obtained of such. The leaf disease on the susceptible Robusta plants so far examined has not been detectable as a separate strain.

One experiment using spores from *Hemileia* infections on *Gardenia gummifera* and *Vangueria* (?) sp. failed to give infection on Coorg leaves.

Further work along these lines is planned for the future. The method of inoculation on detached leaves is to be used for studies on the resistance of the various crosses and self fertilized lines now being developed on the Station. The method will facilitate the elimination of types of high susceptibility to disease in the nursery with much saving of time and space in the field, and at the same time will throw light on the mode in which resistance of Leaf Disease is inherited.

Spore Distribution.--In order to study certain peculiarities of the development of Leaf Disease in areas exposed to and sheltered from wind, a number of glass slides smeared with vaseline were exposed as spore traps on posts erected in two areas of coffee near the Station towards the end of the S. W. monsoon. The slides were arranged so that equal numbers were exposed to each of the four cardinal points of the compass in each area. They were left exposed for one week and then collected and stored in clean slide boxes for microscopic examination. During the period, the wind was consistently in the W. or S. W. as is usual during the monsoon, where it is not changed by configuration of the land.

One area faced west and was exposed to the full force of the wind. The coffee was about five years old and the shade, light. The other area was sheltered from the wind with a gentle eastern slope. The coffee in this area was older and higher, and the shade thicker than in the first area. The status of the disease was markedly more severe in the latter area than in the former. In both places, the slide-bearing posts were about the same height, so that

they were well above the coffee in the first area and slightly above it in the second.

It is admitted that the two areas were very dissimilar in ways other than facing and wind exposure, and that direct comparisons between the number of spores caught are not possible. However, the counts actually made are of interest in connection with the movement of spores in the air. It is unfortunate that the number of slides examined is small, but the work of examination is extremely slow and occupies a great deal of time. The results are given in Table IV.

TABLE IV.

Leaf Disease Spores caught in Spore Traps.

Position of slides		Spores Caught			Average
		Slide 1	Slide 2	Slide 3	
W. (Exposed facing)	...	23	17	21	20.3
S. (" ")	..	36*	6	4	15.3
N. (" ")	...	5	13†	5	7.7
E. (" ")	...	7	3	10	6.7
W. (Sheltered facing)	...	3	4	...	3.5
S. (" ")	...	14	12	...	13.0
N. (" ")	...	17	11	...	14.0
E. (" ")	...	11	16	...	13.5

NOTE.—* 12 groups of spores. † 3 groups of spores.

The markedly greater number of spores caught on the slides facing W. in the series exposed in the windswept area affords interesting proof that the spores move with the wind. In the sheltered areas, there is no such definite movement, and all directions of exposure show a generally similar "catch" of spores except the slides facing West. The low numbers on the western facing in this area are very difficult to explain, unless it be that under the lee of the slope, there is a back eddy of wind from the East. This is not supported by the evidence of the slides facing East.

As has already been stated, the status of the disease was markedly higher in the sheltered area, though the spore-catches were barely as high as in the slides exposed to the west wind. This suggests that in sheltered situations the horizontal movement of spores is much less

marked than in windswept areas. Unfortunately, no data are as yet available with regard to downward movement.

The tentative conclusions drawn from the field observations of 1930 on the influence of wind exposure are supported by these spore trap observations (Seasonal Periodicity of Coffee Leaf Disease. Second Report. Bull. fig. 6. Mysore Government Coffee Experiment Station). In that report, it was suggested that the later development of Leaf Disease on windswept areas was due to the greater wastage of spores. The considerable horizontal movement of spores with the wind in the windswept areas would tend to carry spores rapidly through the air, resulting in wide diffusion of the spores and large losses of spores which would be carried into areas where coffee was absent—jungle, etc.

The possibility of using wind breaks on ridges to act as spore traps is one that, I think, might merit consideration, especially in areas where coffee is growing on two sides of N.—S. ridges.

General Observations on Leaf Disease.—The foregoing sections deal with specific work on Coffee Leaf Disease. In addition, various detached observations made in connection with other work serve to throw light on various aspects of the Leaf Disease problem. Cataloguing such detached notes would serve no purpose at present. Later, it is hoped to summarize all the available data, both observational and experimental, bearing on the development of the disease through the year and the effect of environmental conditions thereon.

Root Diseases.—Work on root diseases has been largely in abeyance. The wood block cultures of *Fomes lamaeensis* have been kept going and evidence of complete penetration obtained. Thin pieces of wood permeated by the fungus have been found to show the brittleness which is characteristic of the disease in the field. Microscopic examination of the wood failed to reveal any marked structural alterations and chemical tests for lignin revealed no apparent reduction in this constituent. Further work along these lines to investigate how the fungus brings about decay are planned but have been held up by other work of a more important nature.

Wood blocks heavily infected with pure cultures of the fungus were buried in contact with roots of young coffee trees growing in tubs. So far, no signs of attack

have been visible though the experiment has been in progress for six months.

Of other root diseases, *Rosellinia* remains secondary to Brown Root Disease, while two other types have come under notice during the year. The first of these has been found occasionally in patches in Mysore and in general characters resembles *Poria hypolateritia*, the Red Root Disease of tea, but it does not seem to be very common. The second is of some importance in the coffee near Gudalur. The characters are rather indefinite and no certain identification has been possible. Cultural work resulted in the isolation of a fungus which in its growth characters showed resemblances to *Fomes applanatus*, a fungus reported by Petch (Diseases of the Tea Bush) as occasionally causing root disease of tea in Ceylon. The same author mentions that it has been reported as a root disease of coffee in South India, but without reference to the authority. As the characters of the disease on the dead tree from which this isolation was made differed somewhat from those of other trees dug out, it is probable that other fungi are also involved.

The majority of the attacked trees showed very little external signs of disease, but on splitting the tap root the wood was discoloured and smelt "mushroomy." In the oldest stages, the wood was spongy and wet. The progress of the disease appeared to be slow as it was only occasionally that a patch of the disease was clearly noticeable. Close inspection revealed in many cases that where a single tree had died suddenly, there were indications of previous deaths in the presence of supplies several years old. In practically every case, a dead stump was present nearby and in one case the spread of disease along a large root of a dead stump to the dying coffee tree was established by careful excavation. In this case, the stump root showed a progressive decay from the dead stump outwards to a point where it was in direct contact with the tap root of the coffee.

Recommendations were made along the usual lines. There does not seem much prospect of any marked advance in the treatment of root diseases until the conditions under which dead stumps and felled logs decay in tropical soils are subjected to comprehensive investigation. An understanding of the succession of organisms involved in the process together with the place in that succession

taken by the few more important organisms involved in root diseases of the crops might provide data which would suggest means of directing that succession along lines unfavourable to the development of root disease fungi, or means of otherwise controlling decay.

Spraying Mixtures—Progress Report.—In the Administration Report for 1930-31, a series of observations made on plots receiving different types of spray mixtures was reported. These were designed to provide an estimate of the effect of the different mixtures in preventing leaf fall resulting from Leaf Disease. Observations of identical type were carried out at approximately the same time during the year under review. The results, together with those of 1930, are given in Table V.

TABLE V.

Effect of Different Sprays on Amount of Leaf held by Typical Branch Systems.

Mixture used	1930		1931	
	Order	Leaf count	Order	Leaf Count
Linseed Oil Bordeaux 10 ozs.	1	6'35±'21	1	6'28±'23
" " " 40 ozs.	2	6'28±'25	7	5'77±'23
" " " 20 ozs.	3	6'09±'19	2	6'23±'25
Casein Bordeaux ...	4	5'90±'18	3	6'19±'24
Fish Oil Resin Soap Burgundy	5	5'57±'23	8	5'66±'26
Resin Soda Bordeaux ...	6	5'50±'16	6	5'94±'20
Alum Bordeaux ...	7	5'38±'24	4	6'00±'28
Resin Soda Burgundy ...	8	4'87±'18	5	5'97±'21
Solbar 3 per cent ...	9	3'10±'11	9	5'12±'19
Check No. spray ...	10	2'40±'13	10	3'13±'17
Bordeaux without adhesive ...	No observation		...	5'40±'19

Taking the data as a whole, there is a general reduction in differences between the different treatments during the present year together with an improvement in the results of the check counts and the treatments which gave poorer results in 1930. This was to be expected as the weather conditions were considered less favourable

for the disease during the very wet monsoon of 1931. Conversely, the results afford an interesting confirmation of the depressing effect of heavy rainfall on Leaf Disease which was concluded from previous observations recorded in the bulletins on "Seasonal Periodicity of Coffee Leaf Disease."

Considering the individual spray mixtures, Linseed Bordeaux in the 10 oz. strength continues to head the list, while Linseed Bordeaux, 20 oz., Casein Bordeaux and Resin Bordeaux hold approximately the same positions as in 1930. Solbar shows again as the least effective. Experiments with this material have been abandoned. Alum Bordeaux and Resin Soda Burgundy show marked improvement in effectiveness, while for some unexplained reason Linseed Bordeaux 40 oz. exhibits a marked drop.

Further data will be required for providing results of definite statistical significance, but it seems probable that either Linseed Oil at the 10 oz. strength or Casein is likely to prove the best adhesives. The problem of the relative merits of Bordeaux and Burgundy mixtures must await further results, but the data obtained suggest that there is no advantage in the latter from the point of view of fungicidal power.

With regard to the use or disuse of adhesives, the results of 1931 suggest that there is a positive advantage to be gained by their use, the differences between the figures obtained with Casein and without being statistically significant. At the same time, the advantage to be gained by spraying without an adhesive as compared with no spray at all is considerable. It remains to be seen from crop yields whether the increment gained covers the cost of the adhesive. In view of the quite high figures for spraying without adhesive and of the fact that the monsoon of 1931 was an extremely heavy one, it seems that the omission of the adhesive in September--October spraying would not seriously affect efficiency of protection.

Time of Spraying and Strength of Spray—Progress Report.—Similar observations to those described in the previous section were carried out in September and in February on a series of large plots receiving spray applications at various times and in different strengths. The results are given in Table VI.

TABLE VI.

Effects of Spraying at Different Times and in different Strengths on Leaf held by Typical Branch Systems.

Treatment	Leaf Counts		Crop in lb.
	September 1931	February 1932	Cherry per 500 trees
1% May and September ...	6'55 ± '22	4'29 ± '17	1425 lb.
0'5% „ „ ...	6'17 ± '19	2'45 ± '12	2059 „
1% May only „ ...	6'39 ± '21	2'22 ± '14	1013 „
0'5% „ „ ...	6'82 ± '20	1'67 ± '16	809 „
1% September only ...	3'31 ± '21	2'38 ± '17	800 „
0'5% „ „ ...	3'34 ± '19	2'34 ± '15	852 „
Checks I „ ...	2'38 ± '19	0'95 ± '11	1829 „
„ II „ ...	2'94 ± '19	1'48 ± '13	1026 „
„ III „ ...	3'47 ± '23	1'70 ± '14	667 „

Unfortunately, the soil and shade conditions vary considerably through the area so that the results are somewhat difficult to interpret. The plots are arranged as follows: One per cent May and September spray, one per cent May spray only, 0'5 per cent May and September spray, 0'5 per cent May spray only, one per cent September spray only and 0'5 per cent September spray only, with check plots between the treatments. Figures are only given for three check plots near the centre of the whole series. The check plots were under treatment during 1930 and the effects of the treatments were still evident in 1931 so that the data are of limited value for this year. The high yields given by Checks I and II in the table are the results of the 1930 treatments to which they were subject.

It can be seen from the September observations that there is no significant difference between the one per cent (5-5-50) application and the 0'5 per cent (2½-2½-50) application. As might be suspected also, the September application, done only a few days before the observation was made, exerted no effect and the results do not differ significantly from Checks II and III. The poorer figures for Check I may probably be attributed to the very considerably heavier crop it was bearing as a result of the previous treatment.

The result of the February observations are more difficult to interpret as matters are greatly complicated by difference in crop yield. Thus, it might be concluded from the significant difference in leaf amount in the two twice sprayed plots as indicated by the observational data that 0.5 per cent mixture was less efficient than one per cent. A reference to the crop yield figures shows that the 0.5 per cent twice sprayed area produced nearly 50 per cent more crop than the one per cent twice sprayed area and the greater leaf loss may be due to the heavier strain on the trees and not to any fungicidal deficiency of the mixture. In the case of the area sprayed only in September, there is no apparent difference in the effectiveness of the two strengths. In the case of the areas sprayed in May only, the 0.5 per cent strength does not seem to have been so effective as the one per cent strength and in this case no explanation based on crop differences is possible. It must be remembered that the heaviest intensity of the disease occurs usually in October and November and it is possible that the 0.5 per cent mixture applied only in May loses its efficiency by the washing of rain sufficient to result in a reduction in leaf amount below that of the trees sprayed with the one per cent mixture at the same time. More definite information on this point must await on further data.

The general course of the results is in agreement with earlier conclusions based on studies of the seasonal behaviour of Leaf Disease. Of the two sprays, the pre-monsoon application is to be regarded as the most important, while the post-monsoon application is secondary to it. It is possible, in wind-swept areas where the wide dissemination of spores retards the development of attacks, that a post-monsoon application alone might be of value, but the risks of failure are considerable.

The figures for crop yield in the areas receiving only one application do not reveal very clearly the greater role played by the pre-monsoon spray. A general inspection prior to the 1932 blossom revealed, however, that the pre-monsoon sprayed areas had formed very considerably more bud than the post-monsoon sprayed areas, so that although the crops from all four of the single sprayed plots were similar, there is every likelihood of a difference being visible in the next crop in favour of the pre-monsoon sprayed areas.

Work along these lines will be continued in the coming year both in September-October and February-March. The results which accumulate from year to year are being filed and taken with climatic data will afford in time a valuable body of material for advice on spraying questions.

Note on Tables V and VI.—The method of obtaining the figures given in the two tables was explained in the Annual Report for 1930-31, and in an article in the "Planters' Chronicle" of July 4, 1931, pp. 315-7. The fraction prefixed by the $\pm$ sign following each figure representing the estimate of the number of leaves per growing shoot is an estimate of the Standard Error which is used in arriving at significant differences.

FLOWER AND FRUIT STUDIES.

Pollen Germination.—Some further work on pollen germination was carried out during the year, but no further results of general interest have been obtained. This year's results seem to suggest a relationship between pollen viability and the atmospheric humidity at the time of flowering, but the results are a little conflicting. In view of the importance of this problem from the point of view of breeding work, it is hoped to arrange for the watering of trees in future seasons with the pollen problem in view, instead of using trees watered primarily for breeding purposes.

Floral Studies.—It was noted in the last report that a number of hybrid plants in the selection plots at the Experiment Station formed no pollen. Investigations made on immature buds showed that the condition of male sterility could be detected readily in January. The condition is associated with malformed anthers, the malformations varying from the absence of pollen sacs in normal shaped anthers to the complete replacement of anthers by petaloid structures. All degrees between these extremes could be found in different plants. The results were placed at the disposal of the Plant Breeding Assistant at the Experiment Station and, in co-operation with him, a large number of Station selections were examined.

Crop Losses during Development.—An announcement was made in the Annual Report of 1930-31 of a series of observations undertaken to investigate the times at which

developing fruit are lost. These observations were carried to a conclusion in December 1931 and a new similar series started in March 1932. A synopsis of the results is given in Table VII. It will be understood that one year's results are quite insufficient to draw any conclusions but in view of the results of the small scale observations of 1930, several points may be commented upon.

As in the observations of 1930, the major portion of the loss occurs in April, May and June. The subsequent losses are negligible and largely attributable to mechanical causes, though a reservation must be made with respect to "Jeloo," a subject which will be considered below.

TABLE VII.
Crop Losses during Development.

Times of loss	No	Percentage of original bud
Original flower bud 1-4-1931 ...	9031	.....
Loss 1.—between April 1st and May 5th.	1850	20.5 per cent
Loss 2.—Unswollen fruit distinguished on May 12th.	989	11.0 „
Loss 3.—between May 12th and June 16th.	2414	26.7 „
Loss 4.— „ June 16th and November 12th.	381	4.2 „
Fruit picked on November 12th ...	3397	37.6 „
Total ...	9031	100.0 per cent

The four sets of losses indicated in the table are clearly separable and form well defined groups, the causes of which remain uncertain.

Loss 1.—This loss is indicated as occurring between the blossoming on April 1st and May 5th, but, in fact more than half of it occurs in the first week after flowering. The affected young fruit initials turned yellow, dried up and fell from the fruiting nodes. In some cases, failure at this point involved whole groups of flowers, and may have been due to defective buds which failed to open normally. In great measure, this loss is probably to be considered as a failure to fertilize.

Loss 2.—This loss did not involve a fall of young fruit, and it is not possible to say when the conditions

giving rise to it originated. It is noted as occurring on May 12th because at this date it was possible to distinguish that a certain proportion of the young fruit was lagging behind in development. These fruit never developed to maturity, remaining only slightly larger than the original pistils present at the base of the flower at blossom time. They disappeared gradually during the course of the year, though a few were still to be found even at harvest. The reason for this failure of development is unknown and will have to be sought by other methods.

Loss 3.—This constitutes the largest single loss in development. Attention was drawn to it in the report of 1930-31, where in a small series of observations, about 11 per cent of the original blossom was affected.

It occurred very suddenly between the 2nd and 16th June in the year under review. The characters of the majority of the fruit falling at this time were the same as those described on page 13 of the annual report of 1930-31. Five hundred fallen fruits found at this period were examined and classified. It was found that 77 per cent showed the characters described—blackening of the bean tissue before the decay of the pulp and a development of white powdery material at the point at which the fruit broke away. Of the remainder, 10 per cent showed the development of the white powdery material at the base of the fruit or fruit stalk but without any decay of the bean tissue, while the rest 13 per cent—were characterized by the splitting of the pulp tissue at the base of the fruit without any other signs of decay. The first two types were all slightly smaller than the healthy fruit at the time of the fall but the last type consisted of fruit as large or larger than the healthy ones.

Attempts to isolate an organism from the fallen fruit were all failures. Microscopic examination failed to reveal any signs of infection in either the dark decaying bean tissue or the white powdery material at the base of the fruit or fruit stalk. This white powdery material was composed of cells which had become separated from one another by the dissolution of the material binding the cells of the tissue together.

All the indications point to physiological causes as the reasons for this fall. These causes will require fuller investigation in the future with special reference to the variation from year to year and the effect of varying environmental conditions on the amount affected. It is

hoped that closer examination of the data may throw more light on the problem, but the work of examination has not been completed.

Loss 4.—This small loss is mainly due to mechanical causes and to the dying back of one or two of the branches under observation. It must be remembered that the branches upon which these observations were made, were all sprayed twice, before and after the monsoon so that losses due to Leaf Disease and Black Rot were practically eliminated.

Taking the figures as a whole, it can be seen that 376 per cent of the original bud reached the stage of maturity in this series of observations.

The records were kept for each of the 96 branches which survived out of the original 100, four being lost by mechanical injury. From the data so recorded, two interesting points emerge.—

1: The branches with the largest number of buds gave lower percentage sets than those with a smaller number.

2. Branches with few leaves at blossom time were liable to large losses in the early stages of development while many leaved branches suffered but small losses. The correlation was by no means complete as some other branches with low numbers of leaves suffered small losses. No branches with large leaf numbers gave heavy early losses.

Examination of the Crop Picked.—The 3397 fruits picked were all cut open and the condition of the beans recorded. A synopsis of the results is given in Table VIII.

TABLE VIII.

Analysis of Fruit Picked in C yop Development Observations.

	Fruit	Percent- age	Beans	Percent- age
Total	3397	.....	6376	.....
Total Peaberry	451	13.3	451	7.1
Total three beans per cherry...	33	1.0	99	1.6
Total Empty beans	119	3.5	129	2.0
Total Black bean	478	14.1	757	11.9

This analysis provided several points of interest in connection with two defects of the final crop. These two are light or empty beans and black bean, both of which would be classed in practice as light or jeloo. It seems that the two are quite distinct.

The type described in the Table as empty beans are beans which contain no endosperm, i.e. the "meat" of the bean is absent, but are completely developed in size and have a normal parchment skin. The most striking feature of this defect is the rarity with which it affects a whole fruit. It can be seen from the Table that, while 119 fruits contained such light beans, there were in all only 129 such beans, and as most of the affected fruit were normal ones it is obvious that the number in which both beans were affected was extremely small. No explanation of this peculiarity can be given at present but this phenomenon may also be due to some irregularity in the complex process of fertilization.

The second type of defect is "black bean," a trouble which has come into considerable prominence during the last year. The defect consists of the replacement of the bean tissue by a dark-brown to black pulpy material which shrivels and dries in the later stages. One or both beans may be affected in a fruit. There are no definite external signs by which the trouble can be diagnosed, though some such fruits bear a few minute pale yellow spots on the surface of the outer skin. These spots however appear to be no more than superficial. In the present analysis, some beans are included among the black beans which are not completely decayed in the manner described, but showed decay or spotting only on a portion of the bean. Intermediate cases suggest that they all probably belong to the same group, but this statement may require some modification in the future. If there is a distinct class of abnormalities among the fruits classed as black bean, it makes up but a very small portion of the total.

The common feature is the absence of any external signs of decay on the fruit coupled with a partial or complete decay of one or both beans. The parchment skin is usually quite normal. The percentage of affected fruit in the collection was 14·7 per cent, a much lower figure than that reported from a large number of estates in various parts of South India during the year.

Black Bean—Progress Report.—As has been mentioned in preceding section, black bean was a serious and widely distributed defect of the crop of 1931. The first reports were received at the end of August and from that time onwards evidence was obtained of its presence in greater or less degree throughout the coffee districts of South India except the Shevaroyes. It was reported from one or two estates in Mysore in 1930, but it was serious on only one and appeared then to be related to a severe attack of Leaf Disease.

A description of the trouble has already been given in connection with the crop loss observations. This description applies generally to all the specimens examined but there are one or two points which require fuller elucidation. At the Experiment Station and on estates in the vicinity, affected fruit did not fall from the tree although the presence of the trouble was established at the end of August. In the report from the Annamalais received in early September, however, mention was made of a heavy fall of fruit and specimens received of such fallen fruit revealed a high percentage of black bean. Where fruits did not fall, they failed to ripen and in many cases the presence of large amounts of the defective fruit was not realized until the time of stripping. In the few cases noted in 1930, the affected fruit appeared to ripen normally and bad vat outturns were obtained from the beginning of crop.

On obtaining the first reports in August 1931, an inspection was made of fruit samples collected in the area where the fruit loss observations were being carried out. Some 200 fruit were cut open and examined and the number of affected fruit recorded. The percentage worked out at about 12 per cent. An inspection of the figures obtained in November from the final crop of the branches under observation shows only an increase of about 2 per cent and this is as likely to be due to the errors of sampling as to any real difference in amount. As the periodic observations show no loss during the intervening period, it seems evident that the affection does not increase with time after September. As yet, there are no data available for earlier periods, so that we do not yet know at what time the condition is first initiated.

In order to see whether the condition could be attributed to Leaf Disease and Die Back, a number of

fruit were collected in September from branches which had lost all their leaves from Leaf Disease and were showing signs of Die Back. The amount of black bean was, if anything, rather lower than in fruits taken from healthy branches. It does not seem that Leaf Disease and Die Back have anything to do with the amount of black bean and this is borne out by its presence in quite as large amount on estates where these diseases are serious as on those where they are not.

Observations were then extended to the manuring plots and samples of fruit were collected from areas receiving Nitrogen alone (N) Phosphoric Acid alone (P), Potash alone (K), a complete manure (N+P+K) and no manure (Check). The samples were rather small and there are no data available to allow a decision to be made as to how far the differences recorded can be considered significant. However, the strikingly high figure for the samples taken in the plot receiving Nitrogen alone deserves closer investigation. The results are given in Table IX.

TABLE IX.

Manuring Treatment and Black Bean.

Treatment.	Percentage Black Bean.
No manure	5.4 per cent
N only	11.3 "
P only	4.9 "
K only	4.1 "
N+P+K	6.3 "

A large series of cultures were attempted to investigate the possibility of the presence of some parasitic organism. These all gave negative results, the only growths obtained being common saprophytic bacteria and fungi which occurred irregularly in the cultures. Examination of the dark bean tissue and the brown juicy liquid pressed out of them failed to reveal any signs of an organism.

Further work is required to provide an explanation of the trouble. So far, the evidence obtained is mainly of a negative character. It is apparently not the result of other diseases and does not seem to be the consequence of parasitic invasion of any sort. It is obviously a

disease of occasional occurrence. As far as it has been possible to trace, its last appearance in noticeable amount was in 1923. This suggests a connection with climatic conditions, but data are at present too meagre for any definite climatic causes to be assigned to the disease. It has been suggested that the heavy rain in August was responsible but in view of the presence of black bean in the 1930 crop in N. Mysore, this must remain doubtful, as 1930 was a year with an abnormally light monsoon rain. I am inclined to consider that the conditions leading up to black bean act earlier than the heavy monsoon rains. There is a suggestion in the data for the early crop losses recorded in the preceding section that there may be a relation between the early June loss and the amount of black bean, a heavy June loss being followed by a lesser amount of black bean and *vice versa*. This possibility has only recently come to light in the study of the data and it has not yet been possible to examine the question critically.

The data for the effect of manures on the incidence of black bean warrant further investigations of this question and it is hoped to take up this subject during the coming year. A study of fruit samples taken at regular intervals will also be made to see at what time differentiation of sound and unsound fruit is possible.

At present, it seems that the disease is the result of physiological disturbances probably connected with the supply of nutritive material under certain climatic conditions.

Mealy Bug and Cockchafer.—Work on Mealy Bug and Cockchafer commenced with preliminary survey in July 1931 and has been continued by the Assistant Entomologist from February 1932. At this early stage in the investigation, there can be but little to report. It seems however that the problem is extremely complex and involves a great deal more than the presence of certain specific insects.

The outstanding feature of the problem is the high mortality of supplies between the ages of one and four years. With this, mortality have been associated the two insect pests mentioned and the investigation is planned to find out what part these two insects play and in what way the high death rate can be prevented, or, at least, substantially reduced.

Mealy Bug (Pseudococcus citri, Riss)?.—At the time of my visit in July, this pest was not serious and it was only towards the end of my visit that I was able to see any heavily infested plants. Judging by the time, these infested plants had been planted in the field and by the number and stage of development of the bugs, it seemed more than likely that the pest had been introduced with the plants from the nursery. This was supported by evidence given by a planter who stated that only in nurseries did this insect give him any trouble.

Later work has shown that Mealy Bug is ubiquitous in these areas and though the idea of nursery origin was a reasonable conclusion in the case noted in July, it does not serve to account for all the cases.

Description of the Bug.—The adult female bug is an oval purplish brown insect densely clothed with a white mealy secretion, the largest attaining a length of 6—7 mm. ($\frac{1}{4}$ in.). They are provided with legs but are not very active, once they have reached the adult stage. Reproduction is by means of eggs which are oval, pale yellow and about 3 mm. long. A single female may lay from 350 to 650 eggs in her lifetime. The eggs remain in clumps surrounded by meal behind the female, who moves a small distance forward to rid herself of the brood, and make room for fresh batches. The eggs hatch in 2—4 days and the young bugs become active 2 or 3 days after emergence and move about to find suitable feeding places. The complete life cycle is in the course of being investigated.

Habits.—The bugs show themselves to be extremely averse to light and this appears to be the reason for their subterranean existence. They can be "acclimatized" to the aerial portions of plants if these are kept in the dark. Occasionally old bugs are found some distance up the stems of *Erythrina* but smaller ones are never found in this situation. It may be taken as certain that Mealy bugs found above soil belong to different species or at least different races and need no further consideration in the problem. The old bugs occasionally found above ground have ceased to lay eggs and are therefore of little further practical importance.

The bugs show rather more activity than is usual with members of this group, but the distances moved are, as a rule, not very great. The period of greatest activity is in

the early stages, when the young are moving away from the egg masses to find suitable spots for feeding.

They are very widely distributed in the soil in the areas where investigations are proceeding. They occur free in the soil on weeds and especially on the roots of *Erythrina* and on the under sides of *Erythrina* loppings lying on the ground. They are not found in soils very deficient in organic matter or where there is an excess of water. In depth, they are to be found down to about a foot.

Nature of Damage.—Their ability to cause damage has been established experimentally. The bugs extract nourishment by sucking material from the cortical regions of the attacked roots. The injury seems at first to stimulate growth and this results in the bugs becoming partly enclosed in hollows surrounded by spongy cellular tissue. The presence of large numbers of bugs all sucking material and encouraging local attempts at callusing at points of injury constitutes a serious drain on the resource of the young plant. The points of injury also provide areas of weakness prone to act as points of entry for the penetration of various rotting organisms. At the same time, young plants with well developed root systems do not seem to suffer very seriously even when bugs are present.

Associated Organisms.—The bugs are attended by the cocktailed and the common red ant. The role they play in connection with the bug remains for further investigation.

A beetle as yet un-identified has been reared from larvæ found among the bugs, upon which the larvæ appear to feed. This insect will also receive further study.

Treatments.—Pot experiments to study the treatments which have been applied in estates and variously reported upon have been started but results are not yet available.

Cockchafer.—The investigations were started with a preliminary survey of the situation in July 1931. A number of pits were dug in various parts of an estate which had suffered very heavy losses of young plants and the number of Cockchafer grubs found was recorded. From 10 pits, 1 yard square and at least 2 feet deep, 44 grubs were recovered, an average of 4.4 per square yard. A further 40 plants were removed to study the condition of the root systems and an area of about 18 inches square

and 1 to 1½ feet deep was excavated at the same time. Twenty grubs were found in these pits, but only three were in close association with the root systems and one of these was dead. In the case of the ten larger pits, the grubs were in no way concentrated around the coffee roots.

Judging by the large numbers of grubs collected by the coolies engaged in cultivation, there was a high soil population of such grubs. At the same time, no direct evidence of their actually attacking the coffee was obtained. At the time it was considered probable that they were one cause of the great losses of young plants but by no means the only one.

A considerable number of sickly plants were then examined. The usual features were a bitten and gnawed appearance of the tap root, absence of lower laterals and a profuse development of young adventitious roots at the soil level. The lower part of the tap root was usually rotting, but no constant features were present to suggest a fungus disease. The level of the main damage was below the level in which the grubs were most plentiful in July, and it appeared as if the causes of damage must have acted earlier.

The results of this preliminary inspection were summarized as follows:—

1. The grubs were not actually attacking the coffee during July.
2. During July, the grubs are mainly in the top 6 inches of the soil which is above the level of the damage on the coffee plants.
3. There is no concentration of grubs around the coffee.
4. General conditions do not seem to favour supplies and the number of malformed root systems is high.

Some observations were made on the characters of the grubs. They are of the typical Cockchafer type, being greyish white grubs usually bent in to a U shape, provided with stout walking legs, a strong brown head capsule and large biting mouth parts. They fall into three main size groups, the largest being about 1½ inches in length. The size groups are not clear cut but the examination of the head capsules suggested that clearly marked stages

could probably be distinguished with their help. No decision as to the number of species involved was arrived at.

Some grubs were put in boxes filled with soil and when these were protected from rain and the surface layers allowed to dry, it was found that the grubs descended to the bottom of the box. Like a number of other Cockchafer grubs their movements in the soil are probably determined by the soil moisture. Applications of Tobacco waste, such as have been in use as a repellent on the estates concerned, to boxes in which grubs were placed seemed to have no effect but the experiment was not very satisfactory. The excavating of a pit filled afterwards with cattle manure in the centre of a box in which a number of grubs were placed at random did not show any marked movement of grubs into the manure. Unfortunately the death rate of the grubs in the boxes was very high.

Work was commenced on the problem by the Assistant Entomologist in February 1932. The first problem was the situation of the grubs during the dry weather. It was considered that they were likely to be very deep in the soil, so the pits were excavated to a depth of 5-6 feet. Forty such pits were dug in 4 estates where the grubs were found in large numbers during the previous monsoon. They were made around sickly plants, in damp spots and around tree stumps and some pits were watered and left for several days. The total number of grubs found was 10, of which 8 were enclosed in mud cells. This result is extremely surprising, and more so, as some plants taken out had fresh injuries of the type attributed to the grubs and which obviously could not have been caused by them.

Attention was then turned to sickly plants and about 200 such plants were carefully dug up and examined. They showed in general poor root development, the production of adventitious roots at the collar and a high proportion of malformed tap roots.

The first adult Cockchafer beetles were seen on March 9th and from about the 15th the numbers seen began to increase. It remains unknown whether these beetles originated in the estates themselves or came in from outside areas. Two kinds of adult beetles were seen, one brown backed and the other grey backed, the latter being found over a shorter period than the former.

The principal food plants were determined as *Erythrina*, Atti, (*Ficus glomerata*) and *Albizzia odoratis-*

sima. Light traps were found ineffective in catching the beetles, but considerable numbers could be caught by hand in the evening. Further work to investigate the life history of these beetles is planned for the future.

At present, it is of course too early to draw any conclusions but the evidence so far collected leaves the part played by Cockchafer grubs extremely obscure.

The possibility of the damage to young plants being due to Nematode worms has been considered. Examination of a number of sickly plants revealed the presence of Nematode worms in the decaying cortical tissues, but that they play any primary part seemed unlikely. Further observations on this point will be made in the future.

Work will be continued at the Field Station at Sidapur where the Assistant Entomologist has been stationed.

GENERAL REMARKS.

The year 1931-32 commenced favourably with (on the whole) adequate and seasonable blossom showers. The monsoon was rather late in starting and after a mild beginning in June and July, developed into an extremely heavy in August. Losses from Black Rot were severe in unsprayed areas where facing and situation favoured the disease. Leaf Disease was however somewhat checked by the constant heavy rain in August. The lighter rainfall conditions of the earlier part of the monsoon had favoured it, but the net effect was to reduce slightly the attacks of the disease in October. During the N. E. monsoon, coffee generally looked in extremely good condition, especially in sprayed areas.

Crops turned out badly, particularly in Mysore and certain parts of Coorg owing to the high percentage of black bean and to losses due to the rain in December.

The December rain was most unfortunate. Besides, a great deal of ripe fruit fall, it gave a fresh impetus to Leaf Disease and at the same time, caused a great deal of new shoot formation at nodes which should have produced flower bud. In spite of this, the general condition of coffee in the early part of 1932 was good and only in a few small areas was there any rain before the end of March.

These remarks apply more particularly to Mysore but reports from other districts followed the same general lines.

Diseases.—Leaf and Shoot Diseases.—In addition to Leaf Disease (*Hemileia vastatrix*) and Black Rot (*Corticium koleroga*), the only other disease of leaves or shoots which came into prominence during the year was Pink Disease (*Corticium salmonicolor*). It hardly reached formidable proportions anywhere but was considerably more noticeable than in previous years. The disease can be recognized by the wilting of branches and the blackening of the fruit at the joints of such branches. Close inspection reveals a very fine fungus web on the under side of affected branches and this extends over affected fruit. On the fruit and to some extent on the branches, the fungus forms little white clumps of threads which are visible to the naked eye. The fungus does not appear to extend on to the leaves but these droop and eventually fall as a result of the attack on the branches. It is a common disease affecting a wide variety of plants, including tea, rubber, citrus fruits, silver oak and numerous other forest and shade trees. It does not seem to constitute a serious pest of coffee. The presence of the disease in 1931, was no doubt, due to the abnormally wet conditions of the latter part of the monsoon. It is amenable to spraying and should not develop seriously on sprayed coffee. Affected branches should be cut out and burned.

One or two minor undetermined leaf spot diseases were reported during the year but they were not sufficiently serious to call for special control measures.

In nurseries, Collar Rot due to *Rhizoctonia solani* was occasionally reported. Recommendations for the control of this disease were made in the report of 1930-31.

Hemileia Vastatrix has been noted occasionally on certain Robusta plants and I am of the opinion that such susceptible plants should be removed and fresh supplies put in or stumped and grafted with a non-susceptible strain. So far, there seems no cause for alarm that Robusta will succumb to Leaf Disease in the same way as Arabica, and experience in Java strengthens this view. At the same time, the existence of physiological strains and the possibility of the development of a Robusta attacking strain makes it desirable that susceptible plants should be removed. In any case, these plants are usually unthrifty specimens and replacement would be desirable on general grounds.

Root Diseases.—The records under Root Diseases have

been dealt with in a previous section. Root Diseases are only exceptionally acute in coffee, though most estates have some areas from which trees are lost year after year, a loss which in estate work is usually classed with the greater losses due to borer.

Insect Pests.—Borer.—Stem borer (*Xylotrechus quadripes*) still constitutes the most serious insect pest. No work on the problem has been carried out by the Scientific Officer, but the matter is under investigation by the Entomological Section of the Mysore Department of Agriculture. There are one or two cursory observations made however which deserve recording. There have been a number of cases of bored trees examined in March-April which suggest that there is a fairly considerable March brood of adult beetles, in addition to the October brood. It seems desirable that removal of bored trees should be done in two rounds, one before this March flight as well as one in the monsoon. The difficulty of burning plants removed in March is considerable owing to the risk of fire but it is highly desirable that the grubs and adults should be destroyed, before the flight occurs.

Bugs.—These have been locally serious and the delay in the commencement of the S. W. monsoon in 1931 aggravated the trouble. Spraying (or brushing when young plants are attacked) with Fish Oil Resin Soap remains the only treatment which checks the attacks.

Minor insect pests include Cut worms, Red Borer (*Zeuzera coffea*) and grasshoppers. The last type of pest caused a slight alarm on one estate in Coorg where a number of promising young plants had their tops badly damaged by the deposition of eggs in the tissues of the green shoots. The number of plants attacked remained small and after the removal and destruction of the damaged portion, no further trouble was experienced. The adults which laid the eggs were not seen.

CORRESPONDENCE AND PUBLICATIONS.

Enquiries have been on the increase during the year. The largest proportion have been in connection with spraying problems and these have been dealt with on the basis of experience at the Experiment Station and elsewhere. Manuring enquiries occupy second place and these have been treated on the basis of the experience of the

Experiment Station and of the Chemical Section of the Mysore Department of Agriculture.

A bulletin on "The Seasonal Periodicity of Coffee Leaf Disease. Second Report" was published as bulletin No. 6 of the Mysore Government Coffee Experiment Station. Three articles, "Spraying and Dusting for Coffee Leaf Disease," "Observations on Spraying Experiments" and "Die Back of Coffee" were published in the "Planters' Chronicle" during the year. A short technical note on "The Existence of Physiological Specialization in *Hemileia vastatrix* B. & Br." was sent to "Nature."

Acknowledgments.—I have to express my very great appreciation for the continued cordial advice and assistance which has been given me at all times by Dr. Coleman and his staff both at the Coffee Experiment Station and at Bangalore.

My thanks are also due to the many planters who have, from time to time, assisted me in various phases of the work here recorded. The work of the Assistant Entomologist in the short period since his engagement has amply repaid his appointment. The greater part of the account of Cockchafer and Mealy Bug are based on his reports. Distinct progress in this problem during the coming year is certain.

W. WILSON MAYNE,
Coffee Scientific Officer.

The Mysore Coffee Experiment Station—Bulletin No. 17

DEPARTMENT OF AGRICULTURE
MYSORE STATE



ANNUAL REPORT OF THE COFFEE
SCIENTIFIC OFFICER, 1937-38

BY

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FOREWORD.

In the present report of the Coffee Scientific Officer which is, as usual, published as a bulletin of the Mysore Coffee Experiment Station, more attention, than in previous years, is devoted to the baffling disease, Black Bean, which has been alarmingly on the increase in some of the estates. An attempt has also been made to get an insight into the apparently inevitable crop losses during development and a relationship between a good set of fruit and the rapid growth of flush after blossom showers is suggested.

The Government of His Highness the Maharaja of Mysore are enforcing the removal of borer-infested coffee bushes—a measure of immense help to planters in mitigating the spread of the disease. With close co-operation between the Entomologist and the Coffee Scientific Officer in carrying out experiments to prevent borer attack, it is hoped that our attempts will meet with success.

T. G. RAMA IYER,
Director of Agriculture.

1st July 1938.

ANNUAL REPORT OF THE COFFEE SCIENTIFIC OFFICER 1937-38.

I have the honour to present the administration report of the Coffee Scientific Officer for the year ending 31st March 1938, dealing with work in progress in connection with coffee problems. As usual, the report contains an account of the investigations in progress and general notes on coffee problems which have arisen during the year. Work has been centred at the Mysore Government Coffee Experiment Station as in previous years.

The Coffee Scientific Officer was on home leave from the beginning of the year until the end of October. During this period the Assistant Scientific Officer took charge of his work and office.

Touring.—The Assistant Scientific Officer visited Coorg twice during the absence of the Scientific Officer in connection with work in progress there. On his return from leave, the Scientific Officer paid a short visit to Mercara to address a meeting of Coorg planters. In February, a visit was paid to the Nelliampathy hills. An address was given at the annual meeting of the Mysore Planters' Association in February 1938.

In connection with proposals to initiate an investigation into the quality of coffee, the Scientific Officer attended the November meeting of the Imperial Council of Agricultural Research and served on the *ad hoc* committee to consider the proposals. He was also invited to serve on the Cinchona sub-committee held at the same time.

Investigations.—Investigation work suffered some unavoidable interruptions owing to the absence of the Coffee Scientific Officer on leave. The Assistant Coffee Scientific Officer carried out routine work under several heads which will be detailed below.

Leaf Disease.—There is relatively little of interest to report under this head for the current year. The study of the behaviour of various families derived from known parents towards strains of *Hemileia* has been continued.

Some difficulties were experienced with stocks of the different strains and a survey of the position at the Station was commenced with regard to the frequency of occurrence of the two strains which have been so far studied. A large number of tests were made of collections of spores made in various parts of the estate and their behaviour to indicator plants determined. It was found that the Strain I (the strain to which Kent plants are normally resistant) was much commoner than Strain II to which Kents are susceptible. It may be said that the coffee in the estate is mainly Coorg.

Further attention has been given to the study of Strain III which has shown signs of some increase in certain families of coffee which proved resistant to the other two strains. Much more difficulty has attended the isolation and culture of this Strain and further study is required.

At present the testing work provides no new results but is necessary to establish firmly the tentative conclusions already reported.

WORK ON SPRAY MATERIALS AND METHODS.

Spray mixtures.—Work on this subject has been considerably curtailed for the reasons stated last year. It may be of interest to note that work in East Africa on the use of certain adhesives bears out the conclusions reached by the work done in previous years and reported in earlier annual reports.

Observations of the usual type were carried out in connection with an experiment to test two copper oxide sprays laid out at the Experiment Station. The results were as follows:—

TABLE I.		Leaf Index.	Percentage Infection.
Bordeaux	...	6'42	40'0 per cent.
Material A.	...	5'98	25'3 "
B.	...	7'35	38'4 "

Owing to an abnormal value in one of the Bordeaux plots which gave a much higher leaf index and a much lower percentage infection than the other two, comparisons are difficult and no definite conclusions can be drawn. The two other materials gave more concordant results in the replications. The materials, more especially B, show some promise and it is hoped that they may be given a more extended trial.

Time and Strength of Spray.—Observations bearing on the time of spray application and the strength of mixture were carried out as in previous years. The data showed no special features. It is of interest to note that the Control unsprayed plots showed a disease intensity in accordance with expectations on the theory that the length of the dry season and the showeriness of the hot weather are primary factors in governing the severity of the disease attack in September—October.

Timing of the Hot Weather Spray.—The observations reported last year bearing on the time of application of the hot weather spray in relation to the blossom showers were repeated in the current year. Though there are some differences, the trend of the results is the same as last year. The results of both years are given in Tables II and III.

Table II.—Percentage of Leaf Survival and Percentage Infection of Surviving Leaves in Plots sprayed at different dates in the Hot Weather. (Cropping Shoots).

Sprayed, Days after shower.	1936		1937	
	Survival. per cent	Infection. per cent	Survival. per cent	Infection. per cent
24	61·9	48·9	56·9	67·0
38	56·7	56·1	63·0	37·4
52	52·6	58·1	60·4	44·4
66	41·1	41·1	38·5	90·2

Table III.—Corresponding Data for non-cropping shoots (*i.e.*, New Growth.)

24	66·3	66·0	78·0	66·8
38	72·3	57·7	76·2	63·2
52	59·0	58·1	72·2	55·0
66	62·8	53·5	63·2	79·2

The success of the treatment is indicated by a high figure for leaf survival and a low figure for percentage infection. An examination of the figures given in Table II shows that in 1936, the first plot sprayed earliest has given the best results while in 1937 the second plot gives the best figures. The most striking feature in each year, is the marked falling off of the last spray results.

The data for the non-cropping shoots show the same general trend, though the differences are less marked. In 1936 the second spray date has given the best figure for leaf survival, the percentage infections differing relatively

little. In 1937, the first three sprays have given generally similar results which are all better than the fourth.

These results fully bear out the conclusion that the success of the spray does not depend primarily on spraying when the largest amount of leaf is available on the trees.

It must be made clear that these data refer to the control of Leaf Disease (*Hemileia vastatrix*) and not to the control of Black rot. In the case of the latter disease, it is obvious from the behaviour of the disease, that it is important to cover the maximum amount of flush and this can best be attained by spraying as close to the onset of the south-west monsoon as possible.

These results afford strong support to the view expressed in Bulletin No. 15, that in the control of Leaf Disease, the total proportion of the flush which can be protected is not the sole criterion for successful spraying. The period during which the leaf is exposed to infection prior to the spray application is also of great importance. The comparative failure of the spray application made about two months after the blossom shower in both years is of considerable interest and importance in connection with spray programmes against *Hemileia vastatrix*.

STUDIES ON THE COFFEE FRUIT AND SEED.

Crop losses during Development.—Observations on this problem were discontinued during the year. Six years' data are available and it was considered desirable to work these up before commencing any further observational work on the subject. The following remarks cover several interesting points which have arisen in the course of these studies and are published here pending a complete account of the whole series of observations.

The work involved the detailed observation of the growth, development and fruit set of 100 typical cropping branches taken at random through an area of about one acre at the Experiment Station which is sprayed in May and September and receives a general fertilizer after the S.-W. monsoon. Records were kept from 1931 to 1936 for the period from the blossom showers until the harvest in each year.

The first striking feature was the close correspondence between the number of flower buds present at blossom time and the number of leaves present on the same branches. The data are given in Table IV.

Table IV.—Flower buds and Leaves on 100 cropping branches at Blossom time.

Year.		Buds.	Leaves.	Buds/leaves.
1931	...	9,330	832	11'2
1932	...	5,380	405	13'3
1933	...	6,946	540	12'5
1934	...	5,310	434	12'2
1935	...	3,054	347	8'8
1936	...	6,130	600	10'2

It can be seen that on the whole there is a close correspondence between the number of leaves present at the time of the observation and the number of flower buds present on the branches. It should be pointed out that the branches used were of the same type (9-11 joints in length) in each year. This observation serves to indicate the great importance of the leaf area in relation to bud production under local conditions, and suggests that adequate supplies of carbohydrates are one of the main controlling factors in determining crop size.

An attempt to study the possibility of a relation between the amount of bud and amount of leaf on each branch in any one season was made by calculating correlation coefficients for each set of 100 observations.

Table V.—Correlation coefficients between Flower buds and leaves present on Crop Branches.

			Correlation Coefficient.
1931	...	...	+ '0046
1932	...	...	+ '0169
1933	...	...	+ '1518
1934	...	...	+ '1830
1935	...	...	...
1936	...	...	+ '0790

All the correlations were positive but very small and quite insignificant. The data suggest that the general crop level in a year probably depends primarily on the effective leaf area, whereas the crop production of individual branches in a given year depends on other factors. It must be understood that the amount of leaf present at blossom time is to be regarded as an indicator of the leaf position on such branches at an earlier period when photosynthesis is active.

The second striking feature which emerges from the study of the data is the wide variations in setting of fruit by different branches in the same year. The general data

for fruit set have been given in earlier reports and need not be repeated here. A study of the set of fruit on individual branches suggested that branches might be divided into two series—those which set well and those which set badly. An inspection of the records showed that there was no suggestion in the area in question that this was a constitutional character. A branch from a given tree might set well in one year and a similar branch from the same tree in another year might set badly. In the first year, more than one branch was sometimes recorded on one tree and in such cases the branches from the same tree varied in fruit setting considerably.

An attempt was therefore made to compare series of branches with similar amounts of bud but which showed wide differences in fruit setting, in order to see if any differences could be seen in their growth and development. The data given in Table VI are those for 1931.

Table VI.—Development Data for Branches showing a Good Set of Fruit and for those showing Poor Set. (24 pairs of branches).

	Good Set.	Poor Set.
Original Bud ...	2,106	2,106
Fruit maturing ...	1,099	535
Original Leaves ...	214	158
Total Hot Weather growth (No. of leaves) ...	224	230
Percentage of growth made in first 3 weeks after blossom ...	58	46

It can be seen that there are two points in which the two sets of branches appear to differ, beside the difference in fruit set. The good set branches show a higher initial number of leaves and a notably higher percentage of their hot weather growth in the first few weeks after blossom. It may also be noted that there is but little difference in the total growth made in the hot weather.

The data have been worked out similarly for four other years and show similar figures. The most striking feature is the difference in the proportion of the hot weather growth expanded in the first three weeks after the resumption of active growth. The actual differences were 12 per cent in 1931, 12 per cent in 1932, 10 per cent in 1934, 10 per cent in 1935, and 7 per cent in 1936.

The figures suggest that there is a relation between a good set of fruit and the rapid growth of flush immediately after the blossom showers. This is further

supported by the fact that in 1934, when the flush was seriously delayed in all branches the set was much lower than in any other year. The difference in the initial number of leaves seems less important as it was only noted in three out of the five years for which the data have been worked out.

These data suggest several obvious lines of work directed to study the possibility of giving practical effect to the results.

The importance of setting on crop production needs no emphasis. It can be seen from Table VI, that equal numbers of cropping shoots carrying similar amounts of flower bud showed a difference of 100 per cent in the number of fruit produced.

In two years a study was made of the branch thickness at blossom time, measurements being made in the centre of the basal internode. In both years the good set branches were thicker than the poor set branches as can be seen from the figures given in Table VII.

Table VII.—The Thickness of Branches which set well compared with those which set poorly.

			Good Set.	Poor Set.
1932	...	...	4'54 mm.	4'14 mm.
1934	...	...	3'75 mm.	3'58 mm.

A statistical examination of these data, using Fisher's "t" test shows that the difference is significant in 1932 but not significant in 1934. It is a matter of common experience that stout branches as a rule set their crop better than thin whippy ones.

With regard to the distribution of crop losses, the general course has been given in earlier reports. In summary, it may be said that the loss of developing fruit occurs generally in three stages, the first loss occurs in the fortnight or so immediately after blossom, the second becomes visible when noticeable swelling starts and consists largely of small fruit initials which never develop and gradually disappear in later months, and the third occurs usually in the early part of the S.-W. monsoon and consists of partly swollen fruit. There is practically no further loss of fruit after the early part of the S.-W. monsoon except such as may be due to mechanical injury or to parasitic diseases such as Black Rot or Die Back.

A comparison of the distribution of loss in the pairs of good and poor set branches shows that the greater loss

in the case of the poor set branches may be distributed over all three stages more or less evenly but is more often concentrated in the first loss. The latter was the case in 1931, 1932 and 1936 and the former in 1935. In 1934, the greater loss in the poor set branches was concentrated in the third loss period. At the same time, the loss at each stage in every year was usually higher from the poor set branches.

Fruit development and defects.—The continuation of studies on fruit development was interrupted during the first part of the year. During the crop season, the widespread reports of serious loss by Black Bean and similar defects led to renewed attention to this disease. The work done reinforced the conclusion reached in previous years that the cause of these troubles must be sought much earlier in the crop season than the harvest time. A study of a great mass of material during the current season has made possible a tentative grouping of a number of defects all of which appear to be fundamentally related. The common feature presented by all the defects lies in abnormalities in the silver skin. The following list represents the defects identified :—

- | | |
|------------------|-----------------------------|
| 1. Black Jelloo. | 4. " Burnt " bean. |
| 2. Spotted bean. | 5. Green bean. |
| 3. Black bean. | 6. Dry and Coated bean (?). |

Of course the actual visible peculiarities of these defects differ appreciably but in all cases, a microscopic examination reveals abnormalities in the silver skin layer. Of these defects, the first and sometimes the second and third, occur as floaters, the second to fifth are all visible in the wet parchment and can be identified on the drying table on the first day after washing. The last has not so far been detected except in dried beans sent up by the curers.

The main complaints received from estates usually refer to class 1 and 3. The former always leads to bad vat out-turns and the affected beans are a total loss. The latter is a very obvious defect and may also lead to poor vat out-turns, though some reach the coast and are garbled out. The remaining defects, although they cause a marked reduction in value, do not result in a total loss as affected beans are marketable as triage.

The studies made in the present year were mainly concerned with the third, fourth and fifth classes, though

a certain amount of attention has been given to the others. The work involved an anatomical study of defective beans and microchemical tests on the tissues.

For convenience, classes 1 and 2 may be considered together. Anatomical studies show quite clearly that Black Jelloo and Spotted Bean are the same defect differing only in degree. The former is characterized by its colour which varies from light brown to black and its lightness. It is usually more or less wrinkled and soft and on drying becomes a mere fragment of a papery texture. The latter defect is characterized by the presence of a clearly defined spot or area which is usually of the same appearance as the surface of the Black Jelloo, dark, soft and wrinkled. A complete series can easily be collected between the complete Black Jelloo and a Spotted Bean bearing an affected area of not more than a millimetre or so.

Microscopically, sections show that the bean tissues have been more or less completely broken down. In the region of breakdown, the silver skin shows an abnormal cellular development and in the Black Jelloo, practically the whole of the bean consists of this abnormally developed silver skin.

Classes 3 and 4 may also be taken together as these also appear to be the same defect differing in degree. The term Black Bean is here restricted to beans which are black in colour and which when wet are smooth and almost normal in shape. They are usually also heavier than the Black Jelloo and frequently reach the drying tables. The "Burnt" Beans show a greater or less degree of brown staining on the bean surface, the discoloration being diffuse and shading off into normal tissue, unlike spotted beans where the spots are sharply defined.

The microscopic structure of these beans shows no actual breakdown of the structure of the bean tissues, but a greater or less proportion of the bean cells show a collapse of their cell contents and microchemical tests suggest that the cell walls have been modified in their composition. Where the surface is black or brown the inner layer of the silver skin shows the persistence of a cellular structure, which is absent in normal beans. The discoloration is caused by a brown layer between this cellular layer of the silver skin and the main bean tissue. It may be remarked that the colour in the Black Jelloo and Spotted Bean is due to a similar layer in the same relative position. This discoloured layer is structureless.

It is probable that classes 5 and 6 may also be grouped together. In these, the only obvious feature apart from the colour in class five is the presence of an inner layer of cells in the silver skin, which is absent in normal beans. This layer consists of small parenchymatous cells four or five cells deep and closely resembles the cell layer in Black and "Burnt" Beans. In normal beans the inner layer of the silver skin is represented only by a collapsed and structureless layer of material. The colour in the green beans occurs in the cells of the inner silver skin layer and although it has not been accurately identified, looks like chlorophyll. It occurs in plastids in the cells. No detailed study has been made of class 6 beyond the examination of soaked beans taken from commercial samples of dried beans, in which it was possible to see the cellular structure of the inner silver skin layer. On drying the green beans invariably give much shrunken beans which can be described as extreme cases of dry and withered beans.

In all these cases it can be seen that the inner silver skin layer bulks largely. In the first two classes, this layer not only has persisted but shows that it has developed large numbers of cells by proliferation and caused a more or less complete breakdown of the bean tissue. In the second two classes, there is no indication of development by proliferation and the breakdown of the cellular structure of the bean is not obvious, though internal changes are indicated. In the third two classes, there is no obvious indication of change of the bean tissues in any way but the cell layer of the inner silver skin persists.

Attention is focussed on the inner silver skin layer. The origin and importance of this tissue has been mentioned in earlier reports. It is undoubtedly through this tissue that food materials and water pass into the bean during the later stages of development. Normally this appears to break down during the maturing of the bean. The anatomical data suggest that in the defective beans this tissue does not break down in the normal way but retains the structure of an active tissue, which in the case of Black Jelloo and Spotted Bean may actually begin to develop on its own account, probably at the expense of the materials already elaborated in the developing bean.

All the evidence that has been collected suggests that these defects are due to a disturbance of the moisture or nutritive supply of the bean during a comparatively late

stage of development. This stage appears to lie sometime in the monsoon period and probably varies with the stage of development the bean has reached at the onset of the monsoon. Certain abnormalities of cereal seeds which are associated with excessive moisture are suggestive in relation to the problem as they show somewhat similar abnormal activity in seed coat tissues.

It was found that in the case of both "Burnt" Beans and "Green" Beans, the loss of weight on drying was constantly greater than in the case of normal beans. Some data collected on this point are given in Table VIII.

Table VIII.—Loss of Weight of "Burnt" and "Green" Beans on Drying.

Expt. 1.		Loss in weight. Per cent	
Normal Beans	...	...	49
"Green" Beans	...	...	54
"Burnt" Beans	...	...	54
Expt. 2.			
Normal Beans	...	...	49
"Green" Beans	...	...	60
Expt. 3.			
Normal Beans	...	...	49
"Burnt" Beans	...	...	53

In all three tests it can be seen that the loss of weight on drying in the case of normal beans was constant at 49 per cent whereas both "Burnt" and "Green" beans showed losses varying between 53 per cent and 60 per cent. It may be said that there was no indication that these defective beans were lighter than the normal beans in the wet condition, except in the case of the "Green" Beans in the second test which were significantly lighter in wet weight than the normal.

These results indicate either a higher water content of the defective beans or a greater power of absorbing water during washing. Unfortunately these tests were only carried out after washing the fermented beans and no tests were made from freshly pulped material. This will be carried out next season, if material is available.

It is clear that the defects originate when the main bean tissue is forming or has already formed. The actual time when this occurs is variable. The only available data refer to the years 1934, 1935 and 1936. In the first year, the change occupied approximately the month of August. In 1935, the first signs of the change were noted about 22nd July but not seen in material examined on

11th. In 1936, the first signs of change were noted as early as the middle of June. It may be noted in this connection that the hot weathers of 1934 and 1935 were dry, whereas that of 1936 was notably wetter. In 1934, defective beans, mainly Black Jelloo occurred to the extent of about seven per cent of the fruit harvested in the Fruit Loss Observations. In the other two years, the amounts were small—about 0·5 per cent in 1935 and 1·3 per cent in 1936. Further observations of this description will be necessary in an effort to get at the factors involved.

Records of a number of years in which Black Bean occurred have been studied but they seem to have few obvious points in common, and no definite conclusions can be drawn. In view of the fact that in bad Black Bean years, reports come in from almost all the districts subject to a heavy S.-W. monsoon rainfall, while in other years, it is merely an odd estate from which reports come, it seems likely that some climatic factor is involved.

Further lines of approach to this problem include the continuation of studies into the course of development of the bean, with special reference to the monsoon period and the study of the water relations of the coffee plant during the same period.

Studies on Coffee Preparation.—Owing to the work on defective beans no further work was taken up on fermentation along the lines noted last year. However, reports have been received that a treatment suggested last year appeared to have some effect in reducing the risks of foxiness in places where it is liable to occur. This treatment consists in washing the partly fermented coffee the morning after pulping and then re-heaping for the completion of the normal period. This report is noted as it may prove useful to other estates where foxiness is liable to occur.

Pale Beans in the Raw.—At the request of a planter, a comparison of the weights of samples of Pales and of normal beans was made during the crop season. The samples were received from Mangalore and consisted of two lots, one of Pales and one of normal beans from the same consignment. It was found that the Pales were about five per cent lighter than the normal beans and this difference was significant on the basis of Fisher's 't' test. The difference is small and it seems rather doubtful whether it would be possible to separate such beans by

their weight differences in the wet condition. Work in another connection suggests that the differences in wet weight are likely to be even smaller than in the dry.

Work on Nematode Worms and Supply Establishment.—Investigations on this subject have been interrupted during the year. Further confirmation of the ability of *Anguillulina pratensis* and *Anguillulina multincincta* to invade and destroy healthy coffee roots has been obtained. The latter species has also been found in the roots of Dadap at the Coffee Experiment Station. Cross inoculation with worms of *A. multincincta* from Dadap roots showed invasion of coffee roots, though in the area in question no damage to coffee has been noted.

Damage to Dadap by *Heterodera marioni*, the gall worm was noted at the Experiment Station on an area where Dadaps were poor. This worm has also been found in Coorg and may be frequently the cause of the poor growth of this shade tree in many areas, as is the case in tea.

During furlough, the Scientific Officer took the opportunity of discussing the problem of eelworm in coffee with Dr. Goodey of the Institute of Agricultural Parasitology at St. Albans. The fruits of that discussion were to indicate that the possibilities of any direct control measures seemed very uncertain.

Through the agency of the Imperial Bureau of Agricultural Parasitology, identifications of material collected in Coorg were obtained. The results confirmed the earlier conclusion that the main agent of the injury to young coffee is the species *Anguillulina pratensis*. *A. multincincta* as a second species attacking coffee was also confirmed.

Control of Borer.—A study of the results of an experiment laid out last year on an estate of the Consolidated Coffee Estates Ltd., gave the following data:—

TABLE IX,

Material.	Treatment.	Date.	Borer Removed.
Mortegg 5 per cent	... Rubbed	... 17-10-36	3'0 per cent
Do	... do	... 28-10-36	0'4 "
Do	... do	... 7-11-36	1'1 "
Do	... do	... 17-11-36	1'1 "
Do	... do	... 26-11-36	1'2 "
Do	... Unrubbed	... 8-11-36	2'0 "
Control	... Rubbed	... 17-11-36	2'3 "
Control	... Unrubbed	... ..	2'5 "

Approximately half acre was subjected to each treatment each half acre being made up of two plots of about quarter acre each.

The differences between the two plots under the same treatment were often considerable and but little can be stated with certainty. There is however, confirmation of the value of Mortegg in all the plots treated in November (including the plot treated at the end of October), with the exception of the unrubbed plots. No great reliance can be placed on this last result as the whole of the removals for this treatment came from one plot at the border of the experiment.

It is obviously very difficult to lay out suitable experiments to test the questions which were set. The comparatively low level of removals even with a severe attack of borer would necessitate a large number of rather large plots for the collection of data of statistical value: moreover, the problem of side or edge effects in the case of a pest like borer is a very serious one.

Control of Green Bug.—Some further trials with mineral oil emulsions similar to those reported last year were carried out by the Assistant Coffee Scientific Officer. At the same time tests were made of the effect of adding both the mineral oil emulsions and Honge Oil to Bordeaux mixture. The addition of mineral oil emulsion to Bordeaux resulted in some reduction in the efficiency of the former, thus confirming tests of a previous year. There was some bug mortality when Honge oil was mixed with Bordeaux at the rate of one per cent and one and half per cent (80 and 120 fluid ozs. per 50 gallons respectively) but hardly sufficient to afford any really adequate control.

Cardamom Diseases.—The Assistant devoted a considerable part of his time at Balehonnur during the Scientific Officer's absence to an investigation of the wart disease (Kaggi Kai) of cardamoms. A full account of this work has been prepared and will shortly be published. The cause of the injuries has been experimentally proved to be due to a species of thrips, whose life history and habits have been worked out. Certain possible control measures have suggested themselves and are in the process of being tried out.

General Notes 1937-38.—At the Experiment Station, blossom showers were ample and timely at the end of March 1937. Other areas were less fortunate and

experienced early blossoms in February. April was a normal month in most areas but May was very dry; at the Station, the May rainfall was markedly below normal. The monsoon was distinguished by a mild June and an exceptionally dry August and following this the N.-E. monsoon was also small.

The most striking features of the year from the point of view of the coffee crop was the extreme earliness of ripening and the extent to which the crop was affected by Black Bean and similar defects. The Leaf Disease situation was not notably severe which is probably to be attributed to the dry conditions in May and early June. Crops were small almost everywhere and the earliness resulted in an unprecedented early conclusion of the harvest.

The early promise for the year 1938-39 was good but in a number of areas blossom showers were poor and budding up was not as good as was at first expected. There was some rain in late December which did not help matters, in some areas actually producing a small blossom. It seemed that the early harvest was associated with early spike development and some areas showed signs of burning off in the very hot March of 1938.

The poor rains of the late monsoon from August onwards was responsible for indications of water shortage and the prospect of difficulties with hot weather spraying programmes.

It is difficult not to associate the high incidence of Black Bean with the abnormal weather conditions of August, but there are no reasons to assume that this was necessarily the case. A high incidence on Black Bean in earlier years was not associated with such weather conditions. It does not seem likely that a direct relationship between climate and this disease will be readily traceable, without a knowledge of the times at which the beans reach critical stages in their development.

Fungus Diseases.—No new fungus diseases were reported during the year nor were there any exceptional outbreaks of the common diseases.

Insect Pests.—Borer continued to be the most serious insect pest on coffee estates. The removals in the year under review were very high and it seems more than likely that the very dry May resulted in the showing up of many attacked plants which might otherwise have been overlooked. There seems no question that the position of

this pest has become much more serious in the last few years. It seems that there are three primary factors responsible for this.

1. There has been a succession of years of poor N.-E. rainfall which has been recognized as an important factor in affecting borer attack.

2. As a result of the very depressed state of the industry, work on many small holdings has been drastically reduced and other areas have been virtually abandoned, with the result that borer removals have become even less efficient than they were.

3. There are indications that removals on well managed estates may have become rather less efficient owing to spraying. It is not suggested that spraying has been responsible for a *direct* increase of borer, although statements to this effect have been made. The influences have been indirect, in that it seems possible that a healthy leafy tree may fail to show symptoms of attack when the soil moisture supply is abundant, although they can be discerned when moisture is short. The labour requirement for hot weather spraying has tended to leave little labour available in the hot weather for borer work. Borer spotting and removal has tended to be more and more concentrated in the monsoon months, when some affected trees will have made a recovery from the symptoms which would be obvious in the dry weather. It is probable that the proportion of trees with concealed symptoms will be greater with spraying than without if they are only marked in the wet monsoon months.

There can be no question that the efficient removal of attacked trees is of primary importance in dealing with borer and this must lie at the base of any attempts to bring this serious pest under control.

Other Work.—While on leave the Scientific Officer visited the Imperial Institute of Mycology, the Imperial Bureau of Agricultural Parasitology and spent a week at the Fruit Experiment Station at East Malling, Kent. An opportunity presented itself of discussing coffee problems with Mr. J. MacDonald, Senior Plant Pathologist to the Kenya Dept. of Agriculture.

A meeting arranged by Mr. Oliver, Director of Indian Coffee Propaganda was attended at which a valuable opportunity presented itself to discuss problems of defects in Indian coffee with members of the London Coffee Trade.

Acknowledgments.—It is once more a pleasure to record my appreciation of the cordial co-operation and assistance I have received from the Director and Staff of the Department of Agriculture throughout the year. In addition, I desire to express my thanks to the officers of the various institutions I visited during my leave and to the other gentlemen with whom I had opportunities to discuss coffee problems, for their kindness and help.

Finally, as in the past, I am glad to thank the many planters who have assisted me in various aspects of the work on coffee problems.

During the year Mr. Subramanyam has been of the greatest assistance, both in the carrying on of routine work during my absence and in his special work in connection with Nematodes, Borer control and Cardamom disease.

W. WILSON MAYNE,
Coffee Scientific Officer.

3RD JUNE 1938.